

ANNALS of SURGERY

A MONTHLY REVIEW OF
SURGICAL SCIENCE AND
PRACTICE

Edited by

Lewis Stephen Pilcher, M.D., LL.D., *of New York*

Associate Editors

W. Sampson Handley, M.S., M.D., F.R.C.S., *of London*

James Taft Pilcher, B.A., M.D., *of New York*

Walter Estell Lee, M.D., *of Philadelphia*

THE OFFICIAL PUBLICATION of the
AMERICAN SURGICAL ASSOCIATION
of the NEW YORK SURGICAL SOCIETY and the
PHILADELPHIA ACADEMY OF SURGERY

Volume XCVII

January--June

1933

Philadelphia & London

J. B. LIPPINCOTT COMPANY

COPYRIGHT 1933 BY
J. B. LIPPINCOTT COMPANY

MADE IN THE UNITED STATES OF AMERICA

CONTRIBUTORS TO VOLUME XCVII

| | |
|--|----------|
| ABBOTT, WALTER D., Des Moines, Iowa..... | 494 |
| ALLEN, SAMUEL S., Ann Arbor, Mich..... | I |
| ALPERS, BERNARD J., Philadelphia, Pa..... | 10 |
| BACHMANN, R. F., New York, N. Y..... | 766 |
| BARBER, W. HOWARD, New York, N. Y..... | 553 |
| BARNARD, LEONARD, Oakland, Calif..... | 19 |
| BISGARD, J. DEWEY, Chicago, Ill..... | 374 |
| BLOODGOOD, JOSEPH COLT, Baltimore, Md..... | 401 |
| BOHRER, JOHN V., New York, N. Y..... | 204 |
| BRENIZER, ADDISON G., Charlotte, N. C..... | 831 |
| BUZBY, B. FRANKLIN, Camden, N. J..... | 387 |
| CALDWELL, JOHN A., Cincinnati, Ohio..... | 161 |
| CARABBA, VICTOR, New York, N. Y..... | 799 |
| CARLSON, HJALMAR E., Kansas City, Kansas..... | 640 |
| CARTER, R. FRANKLIN, New York, N. Y..... | 637 |
| CAYLOR, HAROLD D., Bluffton, Ind..... | 823 |
| COHEN, IRA, New York, N. Y..... | 733 |
| COLEY, WILLIAM B., New York, N. Y..... | 434 |
| COLP, RALPH, New York, N. Y..... | 177 |
| COMPERE, EDWARD L., Chicago, Ill..... | 773 |
| CONNORS, JOHN F., New York, N. Y..... | 528 |
| CONWAY, FRANCIS M., New York, N. Y..... | 425 |
| COUNSELLER, VIRGIL S., Rochester, Minn..... | 717 |
| COX, FOREST W., Rochester, Minn..... | 717 |
| CUTTING, REGINALD A., New Orleans, La..... | 85 |
| DAVIS, JOHN STAIGE, Baltimore, Md..... | 648 |
| DICKSON, THOMAS R., Cincinnati, Ohio..... | 68 |
| DOUGLASS, RICHMOND, Loomis, N. Y..... | 508 |
| EBELING, WALTER W., Philadelphia, Pa..... | 857 |
| FARR, CHARLES E., New York, N. Y..... | 766 |
| FELTER, ROBERT K., New York, N. Y..... | 875 |
| FIELD, WILLIAM H., Brooklyn, N. Y..... | 577 |
| FONTAINE, RENÉ, Strausbourg, France..... | 26 |
| FORTUINE, STANLEY T., Cambridge, N. Y..... | 713 |
| FRIEDMAN, LOUIS, New York, N. Y..... | 844 |
| GARLOCK, JOHN H., New York, N. Y..... | 259 |
| GRANT, FRANCIS C., Philadelphia, Pa..... | 10 |
| GRAY, HOWARD K., Rochester, Minn..... | 882 |
| GROVE, LON, Atlanta, Ga..... | 957 |
| GURDJIAN, ELISHA STEPHENS, Detroit, Mich..... | 327 |
| HALFORD, FRANCIS J., Honolulu, Hawaii..... | 797 |
| HERRMANN, LOUIS G., Strausbourg, France..... | 26 |
| IRELAND, JAY, Chicago, Ill..... | 189 |
| JACKSON, CHEVALIER, Philadelphia, Pa..... | 516 |
| JACKSON, CHEVALIER LAWRENCE, Philadelphia, Pa..... | 516 |
| JOHNSTON, CHARLES G., Philadelphia, Pa..... | 749 |
| JONES, LAURENCE, Kansas City, Missouri..... | 217, 237 |
| JORDAN, CLAUS G., Philadelphia, Pa..... | 226 |
| KAPLIN, IRA I., New York, N. Y..... | 62 |
| KEYES, E. LAWRENCE, St. Louis, Mo..... | 849 |
| KITLOWSKI, EDWARD A., Philadelphia, Pa..... | 648 |
| KULOWSKI, JACOB, Iowa City, Iowa..... | 683 |
| LAROCQUE, G. PAUL, Richmond, Va..... | 74 |
| LAZARUS, JOSEPH A., New York, N. Y..... | 757 |
| LEITHAUSER, DANIEL J., Detroit, Mich..... | 313 |
| LILIENTHAL, HOWARD, New York, N. Y..... | 801 |
| LOVELL, HAROLD W., Ann Arbor, Mich..... | I |
| MAGE, SIGMUND, New York, N. Y..... | 177 |
| MAMIKONOFF, MICHAEL, Baku, U.S.S.R..... | 547 |
| MASON, JAMES B., Philadelphia, Pa..... | 641 |

CONTRIBUTORS TO VOLUME XCVII

| | |
|---|-----|
| McBRIDE, EARL D., Oklahoma City, Okla..... | 310 |
| McIVER, MONROE A., Cooperstown, N. Y..... | 670 |
| MEADE, JR., RICHARD H., Philadelphia, Pa..... | 247 |
| MENVILLE, JOHN C., Baltimore, Md..... | 401 |
| MILCH, HENRY, New York, N. Y..... | 381 |
| MORRIS, JOHN H., New York, N. Y..... | 889 |
| MULLER, GEORGE P., Philadelphia, Pa..... | 226 |
| NARAT, JOSEPH K., Chicago, Ill..... | 800 |
| NEUHOF, HAROLD, New York, N. Y..... | 808 |
| NICKEL, ALLEN C., Bluffton, Ind..... | 823 |
| OCHSNER, EDWARD H., Chicago, Ill..... | 320 |
| OTT, WILLIAM O., Fort Worth, Texas..... | 318 |
| PANKRATIEV, BORIS E., Kazan, Russia..... | 321 |
| PICK, CHAS. J., New York, N. Y..... | 757 |
| PILCHER, LEWIS S., 2nd, Brooklyn, N. Y..... | 577 |
| RADEMAKER, LEE, Philadelphia, Pa..... | 414 |
| RAIFORD, THEODORE S., Baltimore, Md..... | 903 |
| RANSOHOFF, J. LOUIS, Cincinnati, Ohio..... | 68 |
| RAVDIN, ISIDOR S., Philadelphia, Pa..... | 749 |
| READ, JOSEPH C., Atlanta, Ga..... | 957 |
| REICHERT, FRÉDERICK LEET, San Francisco, Calif..... | 503 |
| ROSENTHAL, ARTHUR A., New York, N. Y..... | 757 |
| ROSH, RIEVA, New York, N. Y..... | 62 |
| SEARS, JOHN B., Boston, Mass..... | 910 |
| SNODGRASS, LEEMAN E., Philadelphia, Pa..... | 200 |
| STENBUCK, JOSEPH B., New York, N. Y..... | 528 |
| STEWART, STEELE F., Los Angeles, Calif..... | 485 |
| VAN ALLEN, C. M., Peiping, China..... | 368 |
| VAN NUYS, R. G., Oakland, Calif..... | 19 |
| VASTOLA, ANTHONY P., Waterbury, Conn..... | 724 |
| VICKERS, DENVER M., Cambridge, N. Y..... | 713 |
| WAGNER, LEWIS CLARK, New York, N. Y..... | 394 |
| WALKER, IRVING J., Boston, Mass..... | 706 |
| WEINSTEIN, MANDEL, Long Island City, New York..... | 80 |
| WEINTRAUB, SYDNEY, New York, N. Y..... | 875 |
| WETHERELL, FREDERICK S., Syracuse, N. Y..... | 481 |
| WHITE, RICHARD JOSEPH, Fort Worth, Texas..... | 639 |
| WHITMAN, ROYAL, New York, N. Y..... | 311 |
| WILLIAMS, GEORGE DEE, St. Louis, Mo..... | 828 |
| WINDSBERG, ESKE HARRY, Providence, R. I..... | 693 |
| WOLFSON, WILLIAM L., Brooklyn, N. Y..... | 796 |
| YASKIN, J. C., Philadelphia, Pa..... | 10 |

ANNALS *of* SURGERY

Vol. XCVII

JANUARY, 1933

No. 1

CYSTICERCUS OF THE BRAIN

BY SAMUEL S. ALLEN, M.D.

AND

HAROLD W. LOVELL, M.D.

OF ANN ARBOR, MICH.

FROM THE DEPARTMENTS OF SURGERY AND NEUROLOGY OF THE UNIVERSITY OF MICHIGAN

HUMAN infestation by *Tænia solium*, the pork tapeworm, is dangerous, not so much as a result of the gastro-intestinal manifestations, as from the likelihood of cysticercus invasion of various organs of the body which often proves fatal.¹ Although cysticercus in man is not uncommon in many European and other foreign countries, it is fortunate that the disease is but rarely seen in the United States.

The adult parasite, or *Tænia solium*, was known by the ancients,² and the cysticercus stage has been known since 1558.³ It was not, however, until the middle of the nineteenth century that the relationship between *cysticercus cellulosæ* of pigs and the tapeworm of man was first demonstrated.

Morphologically, the tapeworm averages from two to three metres in length. The head is bulbous in appearance and contains four rounded sucking discs.⁴ Above the suckers is a projection or rostellum with a double row of horny hooklets varying from twenty-two to thirty-two in number, but averaging usually from twenty-six to twenty-eight.⁵ By means of these hooklets the parasite attaches itself to the intestinal mucosa. Below the long, thin neck begin the segments or proglottides, averaging about eight hundred to nine hundred in number. Each segment contains a separate uterus from which a genital pore leads to the surface. The segments of the worm ripen from below upwards, are detached when mature, and are passed from the intestinal canal.

Although the domestic pig is the most frequent carrier of the disease, having the cysticercus usually in the intramuscular connective tissue, it is also found in the sheep, stag, brown bear, dog, cat and monkey. Kuchenmeister (1855), Humbert (1856), Leuckart (1856), Hollenbach (1859), and Heller (1876) have proved that the *cysticercus cellulosæ* of the pig, if introduced into the intestine of man, grows to a *Tænia solium*.² In the larval stage, the parasite appears as a small, rounded, nodular, thick-walled cyst from 6 to 20 millimetres in diameter. The outer, tough, fibrous capsule is formed entirely by the host in an effort to wall off or encapsulate the parasite. Immediately within this capsule is a delicate, thin membrane belonging to the embryo proper, and containing thin, watery fluid. When ex-

amined microscopically, the embryo is seen to have a head possessing four rudimentary suckers and a double row of hooklets, resembling the head of the adult parasite. From the time the ovum is introduced into the stomach until the cysticercus is fully developed requires about three months.

Infection by the cysticercus may take place by the ingestion of the ova on contaminated articles of food, by auto-infection in an individual carrying the *Tænia solium* in the intestine by uncleanness in toilet habits, or by regurgitation from the intestine into the stomach by reverse peristalsis from vomiting. The parasite passes through the wall of the stomach by use of the hooklets, probably entering the blood-stream and being disseminated to all parts of the body. The organs most frequently invaded are the eyes, brain and spinal cord, including the meninges, the muscles, skin and subcutaneous tissue.

In the present paper two cases of cysticercus of the brain are reported; one, a solitary cyst producing a secondary type of hydrocephalus and sudden death; the other, a generalized infection of one cerebral hemisphere, producing the symptoms of brain tumor.

CASE I.—N. A., male, aged twenty-three years, was admitted to the University of Michigan Hospital as an emergency case in a semi-comatose condition. Three days previously he had complained of headache which became progressively worse. Nausea and attacks of projectile vomiting occurred the second day. On the third day, when drowsiness and mental confusion accompanied the increasing severity of the headache, he went to bed and summoned his family physician. Shortly thereafter he became quite stuporous and was removed on the following day to the hospital.

Upon arrival he appeared drowsy, and, although disoriented as to time and place, he responded correctly to some questioning. The pupils were equal, regular, and reacted readily to light and in accommodation. Except for a bilateral sixth cranial nerve weakness the extraocular movements were normal. The remaining cranial nerves were intact. There was no nystagmus nor strabismus. The ocular fundi were somewhat hyperæmic but there was no actual choking of the optic discs. The tendon reflexes were active but equal on the two sides. Ankle clonus was well sustained bilaterally. There was no patellar clonus. The Babinski and other pyramidal tract signs were not elicited. Sense of motion and position of the toes was retained. There were no atrophies, deformities, paralyses nor muscle tremors. Neither was there evidence of any ataxia or adiadokokinesis. The objective sensory examination was entirely negative. The temperature and respirations were normal. The pulse rate was 92 per minute.

Shortly after admission, the patient began to have generalized muscular twitchings followed by severe convulsions. A few moments later his pulse could not be obtained and respirations ceased. Attempts to revive him were futile.

The post-mortem examination showed a marked internal hydrocephalus, produced by a spherical, thin-walled, cystic tumor blocking the posterior part of the third ventricle. The cyst measured 2 centimetres in diameter and was suspended from the ventricular roof. Both lateral and third ventricles were greatly dilated. The brain was very œdematous but no evidence of degeneration was present. The remainder of the examination showed nothing of interest.

Microscopical studies proved the tumor to be a cysticercus cyst showing characteristic budding cells but no hooklets. Its origin was probably the choroid plexus. No evidence of the infestation was found elsewhere in the body.

CASE II.—M. B., female, aged seventeen years, was admitted on September 3, 1931,



FIG. 1.—Frontal röntgenogram demonstrating diastasis of lambdoidal and sagittal sutures. (Case II.)

to the University of Michigan Hospital complaining of headache, dizziness, failing vision and backache. Two months before, she had developed a sore throat followed by chills and fever, headache, and pain in the back. These symptoms persisted for one week. Her family physician advised a tonsillectomy which was done. There was no improvement. Her vision then became noticeably impaired, and the headaches, which were localized to the frontal and occipital regions, grew much worse. The visual disturbance progressed rapidly. About two weeks before admission she began having attacks of numbness and twitching of the right arm and the right side of her face. Vertigo was also frequent. There had been no gastro-intestinal symptoms.

The patient was born and reared in Austria, having emigrated to the United States



FIG. 2.—Lateral röntgenogram demonstrating diastasis of coronal and lambdoidal sutures without evidence of a localized lesion. (Case II.)

only five months before coming to the hospital. Her health had always been good until the onset of this illness. The family history was irrelevant.

The girl was able to speak but little English. She seemed, however, intelligent and coöperative. The skin and appendages were normal. The palpebral fissures were equal. The pupils were equal and reacted normally to light and in accommodation. The extraocular movements were normal except for nystagmus on lateral deviation of the eyes to the left. The nystagmus was more pronounced in the left than the right eye. The corneal reflexes were active. A papilloedema of four diopters was measured in each eye. There was no facial weakness and the tongue protruded in the mid-line without tremor. The tendon reflexes were more active on the right than the left side. The umbilical reflexes were absent on the right. Occasionally suggestive pyramidal tract signs could be elicited in the right lower extremity. These were never definite

nor constant. There were no other pathological reflexes. Evidence of dysmetria, ataxia, astereognosis, or adiadokokinesis was lacking. There were no sensory changes. Sense of motion and position of the toes was unimpaired. Vibratory sensation was felt better at the left than the right ankle.

Röntgenograms of the skull showed diastasis of all sutures, but no evidence of a localized lesion. (Figs. 1 and 2.) X-rays of the chest were normal.

Urinalysis was repeatedly negative, as was the Kahn reaction on the blood. There were 4,840,000 red blood cells per cubic millimetre and 9,700 white cells. The hæmoglobin was 70 per cent. (Sahli). The differential blood examination revealed 79 per cent. polymorphonuclear neutrophiles, 2 per cent. eosinophiles, 17 per cent. small and 2 per cent. large lymphocytes.

After making a diagnosis of an intracranial lesion localized to the left fronto-parietal region, an osteoplastic flap was turned. The dura, although normal in appearance, was found to be under considerably increased pressure. When the middle meningeal artery was clipped and the dura opened, the brain immediately herniated through. A dural flap was turned with its base upwards. The brain was markedly congested, felt quite hard and firm, and had the appearance of a gliosis rather than of softening, which is usually found with tumor. Several small, hard, shot-like bodies were found in the post-central gyrus. These were excised and found to be small, thick-walled cysts. Many others were then located throughout the cortex by palpation and were also excised. The appearance was that of cysticercosis of the brain. (The report from the pathologist substantiated the diagnosis.) A large subtemporal decompression was made, the bone flap returned to position, and the wound closed.

Following the operation the patient was almost immediately relieved of headaches. Her convalescence was uneventful. The papillœdema subsided and her vision improved greatly. Before discharging her home, further blood studies were made without revealing anything additional. Repeated stool examination showed no evidence of the adult parasite or its ova.

The cases demonstrate the two usual types of the infective process; the first, a solitary cyst, producing symptoms only by obstruction of the aqueduct of Sylvius; the second, a generalized cysticercosis of the cerebrum, probably present on the right side of the brain as well as on the left, but producing signs and symptoms indicative of a tumor of the left fronto-parietal region. Had the cyst been in some other portion of the ventricular system in the first instance, it might never have produced any symptoms. The secondary type of hydrocephalus and sudden death resulted from the location rather than the character of the intraventricular tumor. One could at best in this case only suspect the probability of cysticercus.

When the embryo finally reaches its destination in the tissues a definite inflammatory reaction occurs. There is an infiltration of cells, chiefly lymphocytes, around the embryo, an increase in the vascularization, and, if the lesion is within the central nervous system, a proliferation of glia. This produces within the brain a rather severe œdema—especially if a number of the cysticerci are present—with the resulting symptoms of increased intracranial pressure. Fibroblasts from the blood-vessels and many large multinucleated or monster glia cells make their appearance, gradually forming a connective-tissue capsule or wall around the parasite, and a dense gliosis immediately surrounding the capsule.⁶ (Figs. 3 and 4.) At about the end of the third month when the embryo is fully developed, the inflammation



FIG. 4.—Section showing various portions of the larva and the dense glial reaction immediately surrounding the connective-tissue wall of the cyst. Haematoxylin and eosin $\times 16$.



FIG. 3.—Section of *Cysticercus* (Case II) showing head, rudimentary suckers, membranous lining, and dense connective-tissue capsule. Haematoxylin and eosin $\times 16$.

begins to subside. The glial reaction, which is rather dense, subsides somewhat also, and the astrocytes assume a more normal appearance with fewer of the monster cells being present. The end-result is a dense, tough, connective tissue capsule entirely surrounding the parasite and seeming a part of it, and in addition a glial scar surrounding the immediate neighborhood of the cyst. If the parasite is shelled from its host, the connective-tissue capsule remains attached to it, suggesting erroneously that the capsule is a part of the parasite rather than of the host. The cysts in themselves are but slightly toxic.

During the stages when the cerebral œdema is most severe, the intracranial pressure is often quite high. The symptoms of slowly progressive pressure make the attending physician suspect an intracranial tumor. Localizing signs are often absent. If the meninges are involved there may be symptoms of meningitis. There are often rather characteristic psychic changes such as general confusion, disorientation, hallucinations, excitement, failing memory, *etc.* Cases have been said to simulate hysteria, epilepsy, and general paresis. Epileptic seizures, either generalized or Jacksonian in type, are common. Transient tonic spasms and automatic movements have been described. Dizziness and vomiting are common symptoms.³

The course of the disease is more or less intermittent, and usually of longer duration than that of brain tumor. Sudden death, however, when the lesion is within the ventricles, is not uncommon, as shown by the first of the two cases reported.

If the parasite is known to exist in the intestine of the patient, the diagnosis may be facilitated for it is highly probable that the patient has infected himself with the ova or segments. Usually an eosinophilia accompanies *Tænia solium* infestation, but it is not often found in the intermediary or cysticercus stage. Ophthalmoscopic examination, besides showing a papilloœdema, may reveal the parasite within the eye. Its frequency here is even greater than that in the brain. Sullivan⁷ describes a case in which a diagnosis was made in a patient having Jacksonian convulsions and a transient aphasia, upon finding hooklets of the parasite in the discharge from the ear.

Lumbar puncture and spinal-fluid examination may aid in the diagnosis. Discovery of the parasite, eosinophilia, increased brain pressure, a positive globulin reaction and a paretic type of gold sol curve are factors reported by Kulkov⁸ upon which to base a diagnosis of cysticercus of the central nervous system. If, however, as often occurs, a brain tumor is suspected, lumbar puncture should be done with great care.

Röntgenograms may also be of aid by demonstrating calcified cysts as well as evidencing increased intracranial pressure from spreading of the sutures.

But few cases come to operation and most of these because brain tumor is suspected. Mintz⁹ states that only twenty-seven cases had been operated upon up to 1927. In only one of these was there cerebellar involvement.

Complete recovery occurred in four cases, partial recovery in two. Mintz himself reported three cases, in two of which a diagnosis of cysticercus of the fourth ventricle was made before operation. Kimpton¹⁰ reported an excision of a spinal cord tumor which proved to be cysticercus.

Progress in sanitation is gradually exterminating the parasite in the United States. Price¹¹ states that it is considered a "find" to discover it in the swine of Texas, and that it is usually found in counties having a large Negro or Mexican population. In the Philippine Islands¹² the number of infected pigs is astounding, for in 1921, one infected pig was found in every ninety-one which were examined. Rather paradoxical is the incidence of infection in man, however, for in Manila, in twelve thousand autopsies, only two cases were found. In Germany, although the incidence in swine is much lower, that in man is considerably greater,¹³ a situation which holds for many other European countries as well. Quite a few cases have been reported in British soldiers who had seen service in India, and in individuals who had recently been in foreign countries.¹⁴

The two types of cysticercus infections of the brain are reported. In the first case, that of a solitary cyst obstructing the aqueduct of Sylvius, the location of the tumor could have been made by ventriculography. The cyst might have been removed by operation, but sudden death, so characteristic of tumors of the third ventricle, prevented even the making of a diagnosis. In the second case, that of generalized cysticercosis of the brain, the symptoms were those of a brain tumor localized to one region of the cerebrum. It is believed that operation, by ameliorating the acute symptoms, provided at least a good temporary result, and made recovery possible. The large decompression relieved the most acute pressure stage, and since progressive improvement has thus far followed the operation it is quite likely that it will continue. The probability of further improvement is enhanced also by the fact that the patient, now living in the United States and not harboring the adult parasite in the intestine, will not be subject to further infestation.

BIBLIOGRAPHY

- ¹ Priest, Major R.: A Case of Extensive Somatic Dissemination of *Cysticercus Cellulosae* in Man. *Brit. Med. Jour.*, vol. ii, p. 471, 1926.
- ² Braun, Max: *Animal Parasites of Man*, pp. 234-240. Wm. Wood and Co., New York, 1906.
- ³ Broughton-Alcock, W., Stevenson, W. E., and Worster-Drought C.: *Cysticercosis of Brain*. *Brit. Med. Jour.*, vol. ii, pp. 980-982, December 1, 1928.
- ⁴ Cole, Norman C.: *Tapeworms and Flukes*. *Practice of Medicine*, Tice, vol. v, pp. 471-474.
- ⁵ Todd, J. C., and Sanford, A. H.: *Clinical Diagnosis by Laboratory Methods*. 6th edit., pp. 482-495, 1928.
- ⁶ Laserew, W.: *Pathologic Anatomy of Cysticercus of Brain*. *Zeitschr. f. d. ges. Neurol. u. Psychiat.*, vol. civ, pp. 667-688, 1926.
- ⁷ Sullivan, W. C.: *Case of Cysticercus of Brain*. *Jour. Ment. Sc.*, vol. xlix, p. 115, London, 1903.
- ⁸ Kulkov, A. E.: *Diagnosis of Racemose Cysticercosis during Life; Changes in Cerebro-spinal Fluid*. *Arch. Neurol. and Psych.*, vol. xxiv, pp. 135-143, July, 1930.

CYSTICERCUS OF THE BRAIN

- ⁹ Mintz, W.: Surgical Treatment of Cysticercus of Cerebrum and of Fourth Ventricle; 4 Cases. Deutsch. Ztschr. f. Chir., vol. ccix, pp. 104-109, 1928.
- ¹⁰ Kimpton, A. R.: Cysticercus Racemosus (Taenia Solium) Infection of Spinal Cord. Surg., Gynec., and Obst., vol. xxx, p. 198, 1920.
- ¹¹ Price, E. W.: Occurrence and Distribution of Cysticercus Cellulosae in Texas Swine. Jour. Parasitology, vol. xii, pp. 81-83, December, 1925.
- ¹² Africa, C. M., and Sta. Cruz, J. Z.: Cysticercus Cellulosae in Man. Jour. Philippine Islands Med. Assn., vol. vii, pp. 209-215, June, 1927.
- ¹³ Fischer, H.: Cysticercus Racemosus Cerebri. Arch. f. Klin. Chir., vol. lxxix, pp. 248-253, 1903.
- ¹⁴ Evans, F. A.: Cysticercus Cellulosae Cerebralis. Johns Hopkins Hosp. Bull., vol. xxvi, p. 87, 1915.

CHONDROMA OF THE INTERVERTEBRAL DISKS

BY BERNARD J. ALPERS, M.D., FRANCIS C. GRANT, M.D.
AND J. C. YASKIN, M.D.

OF PHILADELPHIA, PA.

FROM THE SURGICAL WARDS OF THE GRADUATE HOSPITAL, AND THE NEUROSURGICAL LABORATORY OF THE
UNIVERSITY HOSPITAL OF PHILADELPHIA

IN THE past five years there has come into prominence a clinical and pathological entity which has hitherto remained more or less unrecognized. This has been described variously as chondroma or enchondroma of the intervertebral disks, fibrocartilaginous extensions of the disk, and cartilage nodes. All probably refer to the same process, but as yet there is no general agreement concerning the true nature of these conditions. The entity in question consists of small cartilaginous extensions into the spinal canal, causing compression of the spinal cord. It is readily amenable to surgical treatment. We have recently had the opportunity of studying such a case, and because the subject is young and the occurrence of such tumors important to recognize, we wish to record the case in point.

Intervertebral Disk Extensions: What They Are.—Extensions of the intervertebral disk cartilages are of two types: (1) Extensions into the vertebral bodies, and (2) extensions into the spinal canal. The extensions into the bodies of the vertebræ need not concern us. They have been well described by Schmorl,¹ and produce no neurological symptoms of which we are aware.

The extension of the intervertebral disks into the spinal canal, however, are of great importance. They are accompanied by evidences of compression of the spinal cord, and their removal is attended by very encouraging results. Leaving aside for the moment the question of the etiology of these disk extensions, something may be said of their gross structure. They are small, cartilaginous extensions of the intervertebral cartilages which are usually to one side or another of the mid-line, most often on the left, are firmly anchored to the disk as a rule, and appear on the ventral aspect of the spinal canal. In a few instances they have been very loosely attached and could be picked out easily with forceps (Dandy²). These projections are firm, discrete, sometimes hard, and are usually covered with a sheet of dura under which they form a more or less prominent intraspinal projection. Their situation varies. Many have been reported in the lumbar region, but many also are found in the cervical portion of the spinal canal (Stookey,³ Elsberg⁴). The clinical symptoms to which they give rise vary, of course, with the level of the cord compression, and with the area of cord which is compressed.

Attention was first called to these tumors by Stookey in 1928. Schmorl had reported a few years previously the extension of small cartilage nodes

into the vertebral bodies, but the recognition of their projection into the spinal canal must be attributed to Stookey. Adson⁵ (1925) mentioned a few cases of this sort in a general study of spinal-cord tumors. As Bucy⁶ has pointed out, the tumors in question are probably much less rare than reports indicate.

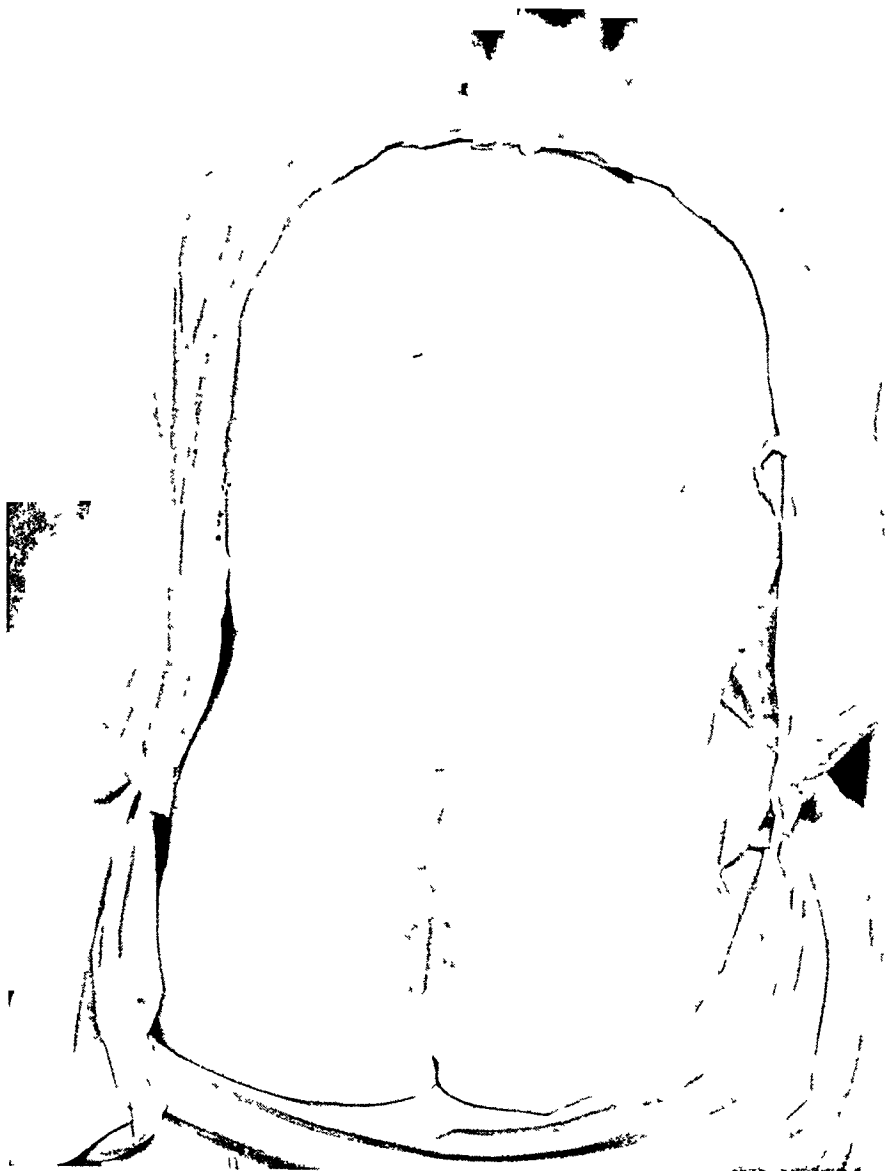


FIG. 1.—This view of the patient taken some time after operation shows the well-healed operative scar.

REPORT OF CASE.—*Severe trauma to back followed by pain in back and later in left leg, the latter persistent. Weakness of left leg. Absence of Achilles Reflex on left. Vague sensory findings to T-8 on left. Campidol injection and arrest of iodized oil at L-3. Operation, with exposure of a small extradural tumor compressing roots of cauda equina on left. Histologically, a chondroma. Complete recovery.*

History.—E. F., a female aged forty-nine years, entered the Graduate Hospital of the University of Pennsylvania in April, 1931, on the service of Dr. William Bates. Three years previously she had slipped and fallen, striking violently on her buttocks. Sev-

eral hours later she developed pain in the small of her back, followed by pain in the left leg, which began to appear about one year after the fall. The pain in the leg, at first intermittent, later became almost constant. It was paroxysmal, beginning in the region of the left hip and radiating down the back of the thigh into the left foot. Often the pain was so severe that she found it necessary to assume the knee-chest position in order to obtain relief. Shortly after the development of her pain she began to notice weakness in the left leg, and at the time of the entrance into the hospital she was unable to walk without a limp. The right leg was singularly free from pain throughout the course of her illness. Within recent weeks she began to notice a numbness of her left leg.

A neurological examination revealed the weakness of the left leg to involve the muscles of the thigh, leg and foot. Movement of the left leg caused pain. On the left side,

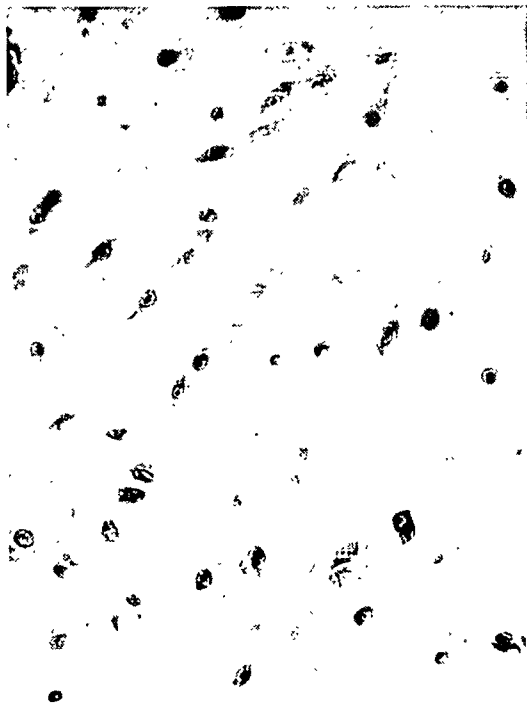


FIG. 2.

FIG. 2.—The cartilage cells seen in this photograph are from the tumor. Here and there are abnormal cellular forms which are not seen in normal cartilage. Hematoxylin-eosin stain.



FIG. 3.

FIG. 3.—On the edge of this tumor are several areas of this sort, composed of fibroblasts which can be traced in their development to cartilage cells. Transition forms from fibroblasts to cartilage cells can be seen in the lower portion of this photograph. Hematoxylin-eosin stain.

extending from the sole of the foot to the level of T-8, there was decreased sensation to touch, pin-prick, heat and cold. The left Achilles reflex was absent, the right was active, and both patellar and arm reflexes were active and equal. The abdominal reflexes were absent bilaterally. There was a positive Lasègue's sign on the left side. Repeated examinations confirmed the sensory findings noted above. While slight, they were nevertheless distinct. It was felt that the patient had a cauda equina lesion which was probably extradural and chiefly on the left side, but that there was also another lesion, probably at T-8.

A lumbar puncture was performed and no subarachnoid block demonstrated. The routine tests were negative. Because of the indefiniteness of the clinical signs and the long duration of the illness—three years—with relatively few clinical manifestations, a campidol injection was done. X-ray after this injection showed that the iodized oil had stopped opposite the body of the third lumbar vertebra. In spite of all efforts to dis-

INTERVERTEBRAL DISK CHONDROMA

place it, the oil remained steadfastly in this situation. Another lumbar puncture was done therefore between the fourth and fifth lumbar vertebræ, and with the needle in this position it was found that a block could be demonstrated. Furthermore, the spinal fluid removed from this locus had a xanthochromic appearance. X-ray examination of the dorsal and lumbar spine revealed an old hypertrophic osteoarthritis, but nothing else of significance.

Operation.—May 18, 1931, Grant laminectomy, removing the third, fourth and fifth lumbar and first and second sacral spines and laminae. On coming down on the lower end of the cord, the dura was dark and seemed to be markedly swollen. The dark and swollen region was found to contain nothing but cerebro-spinal fluid, which was xanthochromic. Just above this area, impinging on the cord from in front, hemping up the dura and compressing the nerve-roots, was a whitish mass. This was extradural and



FIG. 4.—Here and there in the tumor tissue, usually at its periphery, are found these large, multinucleated forms which seem to be characteristic of this type of tumor. Hematoxylin-eosin stain.

anterior to the cord. It seemed to involve the nerve-roots emerging from the third lumbar vertebra. The cauda equina roots were carefully retracted and an incision made into the protruding mass which seemed to arise from a point beneath the transverse processes of the third and fourth lumbar vertebræ. The contents were removed with a curette. They seemed to be cartilaginous in nature. The mass was firmly anchored and arose from the intervertebral disk. The patient developed a post-operative pneumonia from which she recovered. Her leg pain cleared up entirely, and all her neurological symptoms disappeared. The Achilles reflex remained absent on the left side for some time after operation. The sensory findings cleared up after removal of the tumor.

Etiology.—Intervertebral disk extensions are found more frequently in males than females. In a study of 737 cases with cartilage nodes Schmorl found that the majority were in males. His figures include cartilage nodes which had extended into the vertebral bodies. Most of Elsberg's cases, too, were in males. He believes they are rare before thirty, and are commonest about fifty. They do occur, however, in individuals below thirty. In Elsberg's cases the average age was fifty, the age ranging from thirty-eight to sixty-eight. Andræ⁷ has studied the frequency of their extension into the spinal canal. He found in a study of 368 necropsies that there were extensions of the intervertebral cartilages in 15.2 per cent. Schmorl believes

that they are even more frequent than this. In Elsberg's second hundred cord tumors there were fourteen ventral chondromas.

Trauma seems to play an important rôle in their production. Many investigators have found that trauma could be demonstrated in their cases. The importance of trauma as an etiological factor has been denied, however, both by Stookey and Elsberg. The former states that "no history of trauma or of any special occupational activity requiring continuous movements or strain on the cervical vertebræ could be established." In the following table some idea of the incidence of trauma can be gleaned from the reported cases. Twenty-nine reported cases are included in this table, and of these trauma has been reported in only five instances.

TABLE I
Incidence of Trauma

| Author | Nature of Trauma |
|---|--|
| Stookey | None |
| Elsberg | None |
| Schmorl | None |
| Alajouanine and Petit-Dutailis | None |
| Dandy | (1) Severe jolt in riding horseback (2) Strain while pushing automobile |
| Bucy | Lifting heavy piece of iron |
| Alpers, Grant and Yaskin | Severe fall on coccyx |
| Crouzon, Petit-Dutailis and Christophe | Fall on back from height of four metres |

There are two reasons why trauma has not been reported more frequently in the recorded cases: First of all, no effort has been made to determine specifically whether trauma occurred, and then again, its appearance in the history may have been of so insignificant a nature as to be disregarded. Unless the rôle of trauma in the causation of the disorders under discussion is realized, this factor may readily be overlooked. Often it is necessary to obtain a history of trauma in retrospect, and experience seems to show that often such a history is obtainable. In our case the entire symptomatology was directly traceable to the blow, a sudden, severe fall on the coccyx. Such a direct and logical connection does not seem to be common. In all the cases in which trauma has been a factor in the disease, it has been marked, and has usually been sudden and severe, the result of an unusual strain on the muscles of the back.

Prolonged minor traumata are also held responsible by some individuals for the condition. Their relation to the disk growths is less certain. Severe trauma plays an important part in the production of the condition under discussion: it may not be responsible in all instances, but it is a striking factor in some, and in our opinion is more frequent than can be demonstrated from a perusal of the reported cases.

Moreover, these disk extensions are found most commonly in those portions of the spinal canal which are subject to greatest trauma and to most

frequent use. They are found chiefly in the cervical and lumbar regions of the spine. The former is the most mobile portion and probably the least well protected portion of the spinal column, and both through constant motility and direct trauma it is subject to the formation of these disk tumors. The lumbar spine is particularly subject to these growths because it is frequently injured in falls, and is probably subjected to more constant strain than any other portion of the vertebral column.

Location.—The location of these intervertebral disk extensions is not a matter of uniformity. It has been stated by some that these tumors occur most frequently in the lumbar portion of the vertebral column (Schmorl, Andræ, Sashin⁸). This would be true were it not for the extensive experience of Stookey and Elsberg with these growths. In every one of the seven cases of Stookey, and in nine of the fifteen cases of Elsberg, the lesions were in the cervical portion of the vertebral column. Only four of Elsberg's cases involved the lumbar region of the spinal column.

Of the thirty-five cases which we have found reported in the literature, sixteen, or 46 per cent., involved the cervical area of the vertebral column; thirteen, or 37 per cent., were in the lumbar area; and six, or 17 per cent., were found in the thoracic portion of the vertebral column. These growths are therefore somewhat more frequent in the cervical than in the lumbar region on the basis of these few reported cases, but the accumulation of more cases could easily swing the preponderance the other way, or at least equalize it.

TABLE II

Location of Tumors

| Author | Cervical | Thoracic | Lumbar |
|---|----------|----------|--------|
| Stookey | 7 | | |
| Schmorl ⁹ | | 3 | |
| Dandy | | | 2 |
| Bucy | | | 1 |
| Alajouanine and Petit-Dutaillis | | | 2 |
| Elsberg | 9 | 2 | 4 |
| Crouzon, Petit-Dutaillis and Christophe | | | 1 |
| Alpers, Grant and Yaskin | | | 1 |
| Von Pechy ¹⁰ | | 1 | |
| Robineau ¹¹ | | | 2 |

Thirty-five Cases.—Cervical, 16, or 46 per cent., thoracic, 6, or 17 per cent., lumbar, 13, or 37 per cent.

Gross Pathology.—The intervertebral disk projections into the spinal cord vary in size from a pea to a bean. They are usually flat, with a smooth and sometimes lobulated surface, and with a longish, or spindle-shaped form. They are firm, often bony hard, but are frequently soft. They are found practically always in the mid-line or just to one side of it. The posterior longitudinal ligament of the vertebral column covers them, and so does the dura as well. They are therefore extradural bodies. They appear as a gray

to a yellowish-gray structure through the membranes mentioned (Andræ). Usually they are firmly anchored to the intervertebral disk, but sometimes they are found as loose pieces of cartilage (Dandy). Andræ says that in about 50 per cent. of cases these growths are multiple, and it is a matter of great interest that in the cases in which he found these excrescences he states they were never large enough to cause a spinal-cord compression. In some cases, ossification has been observed (Stookey, Robineau,¹¹ Schmorl).

It is presumed (Schmorl, Andræ, Sashin) that the intervertebral disk extensions represent a prolapse of the nucleus pulposus, secondary to a tear in the annulus fibrosus. "As a result of a severe trauma or degenerative changes of the annulus fibrosus, an avenue may be established for the extension of the expansile fibres (of the nucleus pulposus) against the posterior longitudinal ligament." (Sashin.) It seems hardly likely that this is the case, because in sixteen cases which Andræ found there were no direct connections between the disk extension and the nucleus pulposus. There was always intact annulus fibrosus between them. In some instances it has been possible to demonstrate a tear in the annulus fibrosus at necropsy.

The tumors, however, are composed usually of fibrocartilage, and in this respect resemble much more closely the annulus fibrosus rather than the nucleus pulposus. It would seem more likely, therefore, that they develop as outgrowths of the fibrocartilaginous annulus fibrosus rather than form the nucleus pulposus, probably in response to trauma which may or may not produce a tear in the intervertebral disk. There then results a hyperplasia of the cartilage which sometimes reaches a size sufficient to produce clinical signs and symptoms. Only those cases which are large enough to cause symptoms come to our attention, but it should not be forgotten that many cases of this sort exist without evoking any symptoms during life (Andræ). Furthermore, a routine examination of the posterior portions of the vertebral bodies at operation would probably reveal quite a high incidence of these symptomless hyperplasias.

Histological Character of the Growths.—The question arises whether these disk extensions are true tumor growths or whether they are to be looked upon as ecchondroses. The distinction, after all, is one of degree rather than of kind. It is as difficult to determine where an ecchondrosis ends and a chondroma begins as it is to reach the same decision concerning hyperostosis and osteoma. Our case exhibited all the evidences of a cartilaginous neoplasm. The tumor-cells varied much in size and shape, lay in a fibrocartilaginous matrix, and on the borders of the tissue were immature cells of a fibroblastic nature from which transitions to the tumor-cells, many of which were multinucleated, could be traced. Bucy's case showed a similar structure, and he considered it a true cartilaginous tumor. Elsberg was not certain after a study of his cases that they constituted true tumors, and was inclined to believe that they represented ecchondroses or hyperplasias in the strict histological sense.

The size of the growth cannot be a criterion of its neoplastic nature.

Many true tumors are very small, yet they exhibit all the evidences of a neoplasm. The most important evidence of neoplastic formation which we have in our tumor is the presence of fibroblasts on the edge of the growth, from which many transitions to cartilage cells could be traced. Similar cells were present in Bucy's case. These cells were in process of active growth, and would undoubtedly have swelled the size of the tumor if they had been permitted to function longer. Further, evidence of the tumor nature of the growth is given by the multinucleated cells which were quite numerous in our tumor. By some, these cells have been considered to be physalide cells of Virchow, related to the primitive notochord (Alajouanine and Petit-Dutaillis¹²). They are more probably tumor-cells of a multinuclear nature.

True cartilage cells are found everywhere in the fibrocartilage matrix. Sometimes these cells are grouped in twos or threes. They are quite widely scattered, very much as in normal cartilage. The matrix exhibits no peculiarities which stamp it as different from normal fibrocartilage. We could demonstrate no elastic fibres in our tumor.

These tumors are encapsulated—that is, their surface is covered by a thin capsule, except at their base, where they are anchored to the intervertebral disk. It seems probable, therefore, that they may not be removed in their entirety, and that recurrences may appear if any tumor tissue remains behind at the anchorage base.

Clinical Features.—The clinical picture of these tumors varies, of course, with their location. Elsberg, who has studied the largest series of these cases, says that the clinical picture is that of compression of the cord from its anterior aspect with definite motor disturbances and cutaneous sensory loss with relatively little involvement of tactile sensibility, the preservation in most instances of vibratory and joint senses, and the relatively infrequent involvement of the sphincters. Subarachnoid block is more infrequent in these cases than in other tumors of the membranes or cord substance. X-ray of the spine rarely shows evidence of the growth, though Sashin has stated recently that it is possible to detect these tumors by X-ray studies.

In Stookey's study of the cervical ventral chondromas, he found that they were present in three locations: (1) Ventral and in the mid-line, exerting bilateral ventral pressure; (2) ventral and unilateral, producing unilateral ventral pressure; and (3) ventral and lateral, exerting pressure only on the roots, and giving rise only to root signs. "The most characteristic picture is that of marked unilateral spasticity, with atrophy and weakness of the muscles of one or two cervical segments at the level of the tumor and on the side of the spasticity, and changes in pain and temperature sense on the opposite side. Muscle, joint, vibratory, and discriminative sensations are unaltered."

The lumbar ventral chondromas often give rise to cauda equina syndromes.

Here the clinical picture is one of back pain, which is followed sooner or later by pain in the sciatic-nerve distribution, and is attended by muscle wasting, loss of muscle power in the muscles affected, by reflex disturbances,

usually a diminution or loss, by diminution or loss of sensation in the segments affected, and occasionally by sphincteric disturbances. In our case, we were able to demonstrate a relaxation of the anal sphincter. Subarachnoid block may be present either partial or complete (Bucy, Alpers and Grant). Lipiodol injection is of help in many of these cases. In our case the lipiodol stopped at the level of the mass, but in a case of Alajouanine and Petit-Dutaillis, it failed to reveal the mass.

One word of caution is necessary concerning the cauda equina syndromes caused by these tumors. It is more or less a neurological law that cases of bilateral sciatic pain should be looked upon as being caused by a tumor until otherwise proved to the contrary. Cases of unilateral sciatic disease are not usually considered to be due to tumor. Nevertheless, several cases of this sort are reported in these series of tumors (Alpers and Grant, Alajouanine and Petit-Dutaillis, Crouzon, Petit-Dutaillis and Christophe¹³). It seems advisable to keep in mind the possibility of such a tumor when given a history of trauma, followed by backache and unilateral sciatic pain, accompanied by the objective disturbances detailed above. It is a rare cause, to be sure, but a cause which is readily removed, and with good results as a rule.

BIBLIOGRAPHY

- ¹ Schmorl, G.: Die pathologische Anatomie des Wirbelsäule. Verhandl. d. deutsch. Orthopäd. Gesellsch., vol. xxi, p. 3, 1926.
- ² Dandy, Walter E.: Loose Cartilage from Intervertebral Disk Simulating Tumor of the Spinal Cord. Arch. Surg., vol. xix, p. 660, 1929.
- ³ Stookey, Byron: Compression of the Spinal Cord Due to Ventral Extradural Cervical Chondromas. Arch. Neurol. and Psychiat., vol. xx, p. 275, August, 1928.
- ⁴ Elsberg, Charles: The Extradural Ventral Chondromas. Bull. Neur. Inst., vol. i, p. 350, New York, June, 1931.
- ⁵ Adson, Alfred: Diagnosis and Treatment of Tumors of the Spinal Cord. Northwest Med., vol. xxiv, p. 309, 1925.
- ⁶ Bucy, Paul C.: Chondroma of Intervertebral Disk. Jour. Am. Med. Assn., vol. xciv, p. 1552, May 17, 1930.
- ⁷ Andræ, Rudolf: Über Knorpelknötchen an hinteren Ende der Wirbelbandscheiben in Bereich des Spinalkanals. Beiträge zur path. Anat. v. allg. path., vol. lxxxii, p. 464, 1929.
- ⁸ Sashin, David: Intervertebral Disk Extensions into the Vertebral Bodies and the Spinal Canal. Arch. of Surg., vol. xxii, p. 527, April, 1931.
- ⁹ Schmorl, G.: Über Knorpelknötchen an der Hinterfläche der Wirbelbandscheiben. Fortschr. a. d. Geb. d. Röntgenstrahlen, vol. xl, p. 629, 1929.
- ¹⁰ Von Pechy, K.: Zur Kenntnis gutartigen Wirbelsäulengeschwulste. Frankfurt. Ztschr. f. Pathol., vol. xxxvii, p. 562, 1929.
- ¹¹ Robineau: Bulletins et Mémoires de la Société Nationale de Chirurgie, vol. lv, p. 937, July 6, 1929.
- ¹² Alajouanine, Th., and Petit-Dutaillis, D.: Le nodule fibro-cartilagineux de la face postérieure des disques inter-vertébraux. Presse Méd., vol. xxxviii, p. 1657, 1930; Compression de la queue de cheval par une tumeur du disque intervertébral. Bulletins et Mémoires de la Société Nationale de Chirurgie, vol. dxi, p. 1452, October 12, 1928.
- ¹³ Crouzon, O., Petit-Dutaillis, D., and Christophe, J.: Sur un cas de compression de la queue de cheval, d'origine traumatique, par un nodule fibro-cartilagineux du disque intervertébral. Rev. Neurologique, vol. xxxviii, p. 642, May, 1931.

PRIMARY HÆMANGIOMA OF THE SPINE

BY LEONARD BARNARD, M.D. AND R. G. VAN NUYS, M.D.
OF OAKLAND, CALIF.

THE diagnosis of primary hæmangioma of the spine is a comparatively recent clinical entity. The considerable number of these found at post-mortem examination warrants the assertion that this pathology must often be incorrectly diagnosed. We wish here to present one case of hæmangioma involving the spinal column, which has been proven by biopsy, and one additional, which we believe so typical that the diagnosis is assured.

The first published röntgenogram of hæmangioma of the osseous system was that of Hitzrot,¹ in 1917, but it remained for Perman,² in 1926, to give us our first proven case of primary hæmangioma of the spinal column. When we realize from the work of Topfer,³ in 1928, Putschar,⁴ in 1929, and Schmorl⁵ that this pathology is found in 11.93 per cent., 6 per cent. and 10 per cent., respectively, of the vertebral columns examined at autopsy, it is easy to see that the wide divergence between clinical and laboratory findings must constitute considerable error in diagnosis. Makrycostas⁶ found eleven cases post-mortem, none of which had given symptoms ante-mortem, and this is the rule with the great majority.

In a recent excellent paper, Bucy and Capp⁷ have given us the criteria for diagnosis of this condition, after having reviewed all the published cases of involvement of the spinal column together with similar findings in the remainder of the osseous system. To the previously reported eleven cases showing symptoms they added another, and admirably summarize the röntgenological and pathological findings.

In the clinical cases previously reported, the diagnosis was concurrent with a compression myelitis, and diagnosis was always made after surgical work for the relief of the latter. It is the belief of Bucy and Capp that this diagnosis should be made from the röntgenograms, and we believe that the cases herein reported bear out this conclusion. There is a characteristic röntgen finding in primary hæmangioma of the spinal column.

The apparent incongruity between the pathological and clinical in this lesion is, in good part, accounted for by the fact that the only symptomatology so far reported has been that which results from the extension of the process through the cortex and into the spinal canal, producing compression symptoms. In all of Topfer's cases there were no clinical findings to suggest the presence of these lesions. This, then, leads us to the conclusion that the principal value of the diagnosis of these cases must lie in its exclusion in differential diagnosis of lesions of the vertebral column. At the same time, it is worthy to note from the cases herein reported, less severe symptoms may suggest this diagnosis.

These tumors vary greatly in size from that of a pea to complete involvement of the entire body and pedicle. There is a predominance in the female of two to one. The most common site is in the lower dorsal and upper lumbar vertebræ, and the early twenties are the most common ages of occurrence with clinical symptoms.

Differential diagnosis presents the following to be considered.

(A) *Tuberculosis*.—The absence of abscess formation with the attendant fébrile and general symptomatology serves to differentiate the moist type. The dry type (*Caries sicca*) may present some difficulty, but if it is remembered that hæmangioma practically never results in compression of the body, as well as the characteristic appearance of the röntgenograms, differentiation should not be difficult.

(B) *Osteomyelitis*.—The chronic or subacute types will present difficulty from the röntgenographical side, but clinical symptomatology should be more clear-cut. (Abscess formation will be the ultimate differentiation point.)

(C) *Malignant Tumors*.—(1) Metastatic carcinoma will be excluded by the discovery of the primary focus, the severity of clinical symptoms, the extensiveness of the disease, and the absence of typical destruction, together with the progress of the condition. From the röntgenological standpoint, as well as the clinical, the röntgenographs with fewer but denser lamellæ in hæmangioma clearly differentiate. (2) Sarcoma, while primarily a rare finding in the spine, could give considerable difficulty and must rest on progress or biopsy for exclusion.

(D) *Other Inflammatory Processes*.—Among these actinomycoses, and echinococcus should be considered, but the clinical picture with a more extensive destruction makes their confusion unlikely.

(E) *Kummel's Disease (Post-traumatic Kyphosis)* presents a wedging of the vertebral body with a history which is suggestive.

All of these can be readily ruled out if the appearance of the röntgenogram in hæmangioma is remembered. The presence of a porous appearance with striæ, the lime content of the lamellæ undisturbed or increased, and the absence of compression, is diagnostic.

CASE I.—Mrs. J. D., twenty-two years of age; Portuguese-American; housewife. Referred by Dr. A. Reis, of Oakland.

Complaint.—Recurrent periods of loss of consciousness—six months. Pain in low back—six months. About six months ago she began having periods of loss of consciousness, which occurred at irregular intervals with gradually increasing frequency. These have come to be a great source of fear to her and are the reason she presents herself for examination. These have been traced to a dislike of her husband, and have not recurred since they have separated. There has also been occasional pain in her low back, which bears no relation to her above complaint or to any physical effort. She can move in all directions without limitation. This pain, she suggests, may have been due to striking her back against a table previously.

Married two years ago. Menstrual history normal. No pregnancies. Has always been well. Does not recall any childhood diseases. No history of injury other than above stated. Mother and father alive and well. Nothing suggestive of family weakness or inheritable deficiency.

Laboratory.—Blood Wassermann, negative; urine, normal; blood count, slightly elevated white blood count with normal differential. *X-ray examination*.—Antero-posterior and lateral of skull in stereo—normal. Anteroposterior and lateral of dorsal spine—negative. Anteroposterior and lateral lumbar spine—disclosed a destructive process with retention of normal lamellæ, involving the body, transverse process and pedicle of the third lumbar. Vertebral diameter normal—no compression. The right transverse process is enlarged over the left. (Fig. 1.)

HÆMANGIOMA OF SPINE

She is a well-nourished and developed young woman of stated age. Normal throughout except for tenderness on pressure over the third lumbar and muscle spasm incited by percussion over it. Movements of spine free. No palpable deformity or mass noted, except a suggestion of a fullness on the right flank. Reflexes—greatly hyperactive throughout. Sensation—intact throughout. Pelvic and rectal examination—negative.

The diagnosis of Doctor Van Nuys was a hæmangioma of the vertebræ. It was not clear at this time if there was any relation between this and the cerebral symptoms manifest. The differential diagnosis was between a chronic osteomyelitis and a hæmangioma. A biopsy by puncture was first tried. The needle ran into hard bone and no material suggestive of an osteomyelitis was found in smears made. September 11, 1930, surgical biopsy was done, and through a right lateral incision by muscle splitting the



FIG. 1.—Anteroposterior spine.

Lateral spine.

FIG. 1.—Röntgenogram of Case I. Primary hæmangioma of the spine, showing a destructive process with retention of normal lamellæ involving the body, transverse process and pedicle of the third lumbar vertebræ. Note the vertebral diameter is normal—there being no compression.

transverse process was exposed. Considerable bleeding was encountered. The bone in the process was hard and resisted a curette very positively. Two pieces were finally secured for sectioning. Extensive hæmorrhage necessitated packing, which finally controlled it.

For some weeks following she complained of pain along the second and third right root distribution, probably the result of trauma to them at surgery. This gradually cleared.

The sections were made by Dr. W. Reich, who reported: (Fig. 2.)

Gross appearance.—Two small scraps of bony and soft tissue submitted. *Sections* show bony tissue which presents no apparent abnormalities. The soft tissue is composed largely of tissue presenting the histology of an angioma. Numerous small capillaries

lined by low cuboidal cells permeate this tissue. Many of the capillaries contain red blood-cells; in places the endothelial lining appears hyperplastic. The capillaries lie imbedded in a delicate fibroreticular stroma which exhibits a very mild degree of small round-cell infiltration. Smooth muscle, fat and fibrous tissue compose the remainder of the sections. *Histopathological diagnosis*—angioma.

She was then referred to Dr. S. A. Jelte, who administered deep röntgen-ray therapy, the dosage of which was over the affected vertebræ.

Recent X-rays after this treatment seem to show a recrudescence of the lesion with increasing density in the bony structure of the vertebræ.

On comparing this case with that of Perman's, there is a marked similarity in the X-ray pictures—there is absence of compression with a motley thinning out and a porous appearance. The lamellæ have a normal lime content.

To summarize we have here a young woman with an indefinite lesion of her third

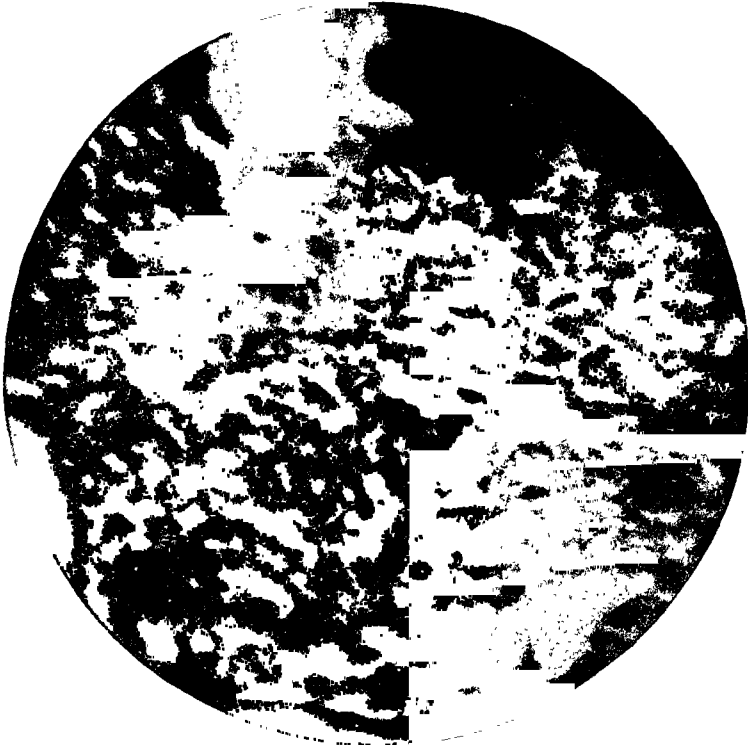


FIG. 2.—Sections of angiomatous tissue removed at biopsy from Case I. Note numerous small capillaries imbedded in a fibroreticular stroma.

lumbar vertebræ, involving the pedicle, arch and transverse processes, as well as the body, without compression, in which a diagnosis of hæmangioma was made pre-operatively and confirmed by biopsy.

CASE II.—S. M., forty-two years of age; white; school teacher; married. First observed at Berkeley Health Center and later at Fairmont Hospital.

Complaint.—Pain in the back, eleventh and twelfth ribs, with epigastric distress and general abdominal soreness. She has always been in poor health since childhood. At seven years of age she had meningitis following a fall on the ice. Her present pain is present on awakening and worse in the mid-forenoon and afternoon. It is relieved by codeine grains 1, which she has been taking three to eight times daily. The back-ache is worse on fatigue. During the past two years pain has become generalized over the body. She has a very poor appetite, repeated attacks of nausea with pain in the right upper quadrant. During the past twelve years she has lost thirty pounds in weight. Gall-stones have been present in previous X-rays. She has undergone many

HÆMANGIOMA OF SPINE

methods of treatment, but without relief of her symptoms. There is occasional burning with nocturia one to three times. She had typhoid fever at the age of thirty-five years. Fistula in rectum at the age of fifteen years. Tonsillitis and influenza many times. Married; one child alive and well. Menstrual history normal. She is a fairly well developed and nourished white woman, appearing forty years of age, intelligent and coöperative.

Her abdomen is soft and thinly covered. Suggestion of a mass below the right costal margin. Tenderness on pressure in mid-epigastrium and gall-bladder area. There is a marked area of hyperæsthesia across the umbilical zone following very definitely the course of the eleventh and twelfth dorsal nerves. There is pain on pressure over the twelfth rib, which she states involves the whole body.

There is tenderness complained of on pressure over the spinous processes of the sixth dorsal to the fourth lumbar vertebræ. There is a limitation of motion in move-

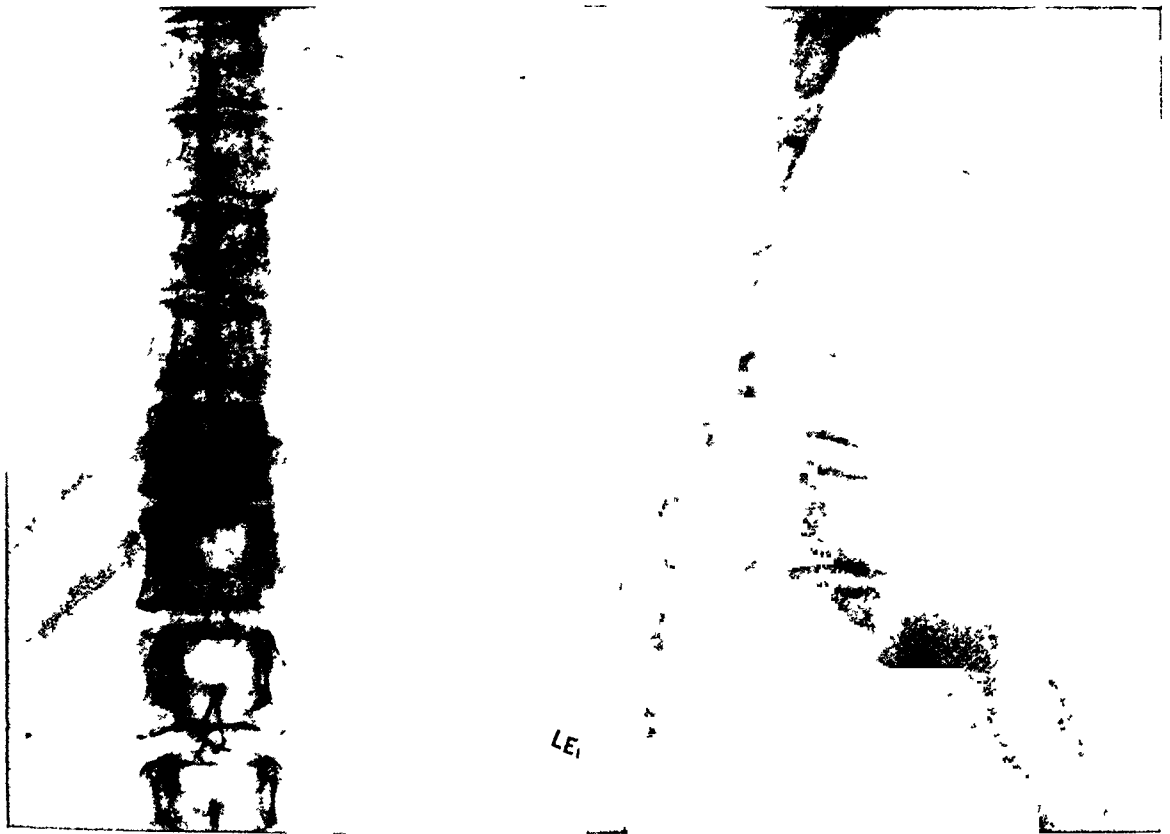


FIG. 3.—Anteroposterior spine.

Lateral spine.

FIG. 3—Röntgenograms of Case II. Hæmangioma of the spine. Note the porous appearance in the tenth dorsal vertebra with diminution in the number of lamellæ but normal lime content.

ments of the dorsal spine with muscle spasm and complaint of pain centering about the eleventh dorsal vertebra. *Blood Wassermann*.—negative. *Blood*.—Hæmoglobin, 90 per cent.; red blood-cells, 4,290,000; white blood-cells, 6,650; polymorphonuclears, 60 per cent.; lymphocytes, 36 per cent.; mononuclears, 3 per cent.; basophiles, 1 per cent.

In the Röntgen-ray pictures anteroposterior and lateral films of dorsal spine show an alteration in the tenth dorsal as follows: Porous appearance of the body with diminution in the number of lamellæ but normal lime content. Lateral extension into rib. No compression. (Fig. 3.) This same picture is seen in X-rays made in 1928 by Dr. S. A. Jelte. There is no progress in the disease. At this time he had given her deep röntgen therapy without any relief of symptoms.

Her entering diagnosis was metastatic carcinoma of the spine, but in view of her not being the picture of this condition and in the absence of finding the primary focus, her gall-bladder was treated medically. Diathermy was given over the area of the spine complained of. She improved under this treatment. Later her gall-bladder and appendix

were removed surgically and showed chronic inflammation. She recovered from this and has been quite well since. Last report, April, 1931, she is working steadily and has no complaints of her back condition.

Discussion.—The etiology of this condition is obscure; however, the known vascularity of the vertebral body with its large veins in the spongiosa anteriorly permits an adequate site for their origin. Putschar has divided them into two groups, the first and most rare composed of those which occupy the central point in the anatomical condition with destruction of the bone involving the arch and pedicle, and giving marked clinical symptoms; the second comprising those which have occasioned no symptoms during life and occupy a minor position, *i.e.*, are not blastoma but venous enlargements in preëxisting cystic or degenerative areas of the body. He admits that externally no changes may be recognized in the vertebræ to contrast these two groups.

We are inclined to agree with Putschar, for in no other way can we reasonably account for the rarity of clinical findings as compared with the post-mortem findings.

The first case herein reported would then belong to the first group—being present in a young individual, producing destructive changes with definite clinical symptoms, also responding to Röntgen-ray therapy.

The second case, occurring in an older individual, produces changes suggestive of the first group. However, its stationary appearance over three years with lack of response to deep-ray therapy makes its classification somewhat doubtful.

Treatment has been clearly outlined by previous writers and resolves itself into laminectomy if pressure symptoms are present followed by radiation therapy. In our cases one seemed to respond to deep Röntgen-ray treatment, while the other was apparently unaffected, though there has been an arrest of symptoms. It might reasonably be assumed that the first group in Putschar's classification would respond to radiation, while the second would not.

From the post-mortem examinations it is certain that approximately 10 per cent. of spines show this pathology. The number of these cases, as Makrycostas brings out, can be increased as desired by continued examination of vertebral columns.

SUMMARY

(1) Primary hæmangioma of the vertebræ is a comparatively common condition but rarely gives rise to symptoms. Ten per cent. of post-mortems demonstrate it.

(2) Diagnosis should be made from the röntgenograph which is typical.

(3) There are apparently two types, one being a true neoplasm and producing symptoms, the other a telangiectasis into a previously pathological vertebræ.

HÆMANGIOMA OF SPINE

BIBLIOGRAPHY

- ¹ Hitzrot, J. M.: Hæmangioma Cavernosum of Bone. ANNALS OF SURGERY, vol. lxxv, pp. 476-482, 1917.
- ² Perman, E.: On Hæmangiomata in Spinal Column. Acta. Chir. Scandin., vol. lxi, pp. 91-105, 1926.
- ³ Topfer, D.: Über ein infiltrierend Wuchsendes Hamangiom der Haut und multiple Kapillarektasien der Haut und inneren Organe; Zur Kenntnis der Wirbelangiome. Frankfurter Ztschr. f. Path., vol. xxxvi, pp. 337-345, 1928.
- ⁴ Putschar, W.: Über Gefäßgeschwülste in der Wirbelsäule, Z. Schor. f. Kreislauforsch., vol. xxi, pp. 495-500, 1929.
- ⁵ Schmorl: Quoted by Putschar.
- ⁶ Makrycostas, K.: Über das Eirbelangioma, Lipom und Osteom. Arch. of Path. Anat., vol. cclxv, pp. 259-303, 1927.
- ⁷ Bucy, P., and Capp, C.: Primary Hæmangioma of Bone. American Jour. of Roentgenol. and Radium Ther., vol. xxxiii, pp. 1-34, 1930.

POST-TRAUMATIC PAINFUL OSTEOPOROSIS

By RENÉ FONTAINE, M.D., AND LOUIS G. HERRMANN, M.D.

OF STRASBOURG, FRANCE

FROM CLINIQUE CHIRURGICALE A (PROFESSOR LERICHE), UNIVERSITÉ DE STRASBOURG

THE fact that the osseous frame-work of the body undergoes rapid and extensive physico-chemical changes under the influence of the circulatory disturbances that frequently follow traumatization of an extremity, emphasizes that the bones are not inert supporting structures with a fixed and unchangeable constitution, but that they are able to react in exactly the same way as the other tissues of the body.

After an extensive study of the post-traumatic vasomotor syndromes of the extremities, made over a period of many years, Professor Leriche has demonstrated the great importance of one special variety of the syndrome which is characterized by constant severe pain associated with stiffness of the neighboring joint or joints. This variety is relatively common, it causes marked disability and it greatly prolongs the convalescence of the patient. It is our purpose to give a complete study of this post-traumatic painful osteoporosis and to show some of the striking benefits that have been obtained in such cases by operations upon the sympathetic nervous system.

Historical review.—In 1900 Sudeck described acute reflex atrophy of bone and established it as a clinical entity. His first report concerned the type of acute atrophy that follows inflammatory processes of the articulations, but later he described a type which he called post-traumatic reflex atrophy of bone. He clearly differentiated between the type following fractures of bones, trauma to articulations, and simple torsion of the joint. He compared the reflex atrophy with the type described previously by Virchow, Charcot, Chambers, and others in relation to certain nervous diseases, especially tabes dorsalis and syringomyelia.

As early as 1877 Wolff described trophic changes in the extremities of adults and disturbances of growth and trophic changes in children following infectious arthritis or resection of a joint. A critical analysis of these cases by Cassirer in 1912 seems to show that the changes observed by Wolff were actually the end-results of bone atrophy.

In 1901 Kienböck added further to the clinical description of the disease entity and he gave an accurate description of the röntgenological changes that are characteristic of it. Both Sudeck and Kienböck showed that inactivity could not account for the severe degree of atrophy, that it appeared much earlier than the atrophy of disuse and that in many cases the atrophy of the bone came on while the extremity was still in use.

Exner (1902) made an accurate gross and microscopic study of the atrophic bones. Nonne (1902) described similar atrophy of bones associated with pathological lesions of the peripheral nerves. Imbert and Gagnière

(1903) and Destot (1904) also added to the clinical description and röntgenologic picture of this disease. Benkwitz (1906), Ziesche (1907), Bibergeil (1911) and Brandes (1913) reported many interesting clinical studies in Germany, while Bienfait (1907), Delherm (1911), Moreau-Gimelli (1912) and Halipré (1914) made the disease entity known in France. In 1919 Hitschmann and Wachtel described typical cases of osteoporosis following severe frost bites. Dubs (1921) reported extensive osteoporosis following burns, but he emphasized that the extent or severity of the osteoporosis bore no relation to the extent or degree of the burns. Osteoporosis was only initiated by the burns as it continued long after the burns had healed.

Legg (1908) made a study of the atrophy of bone that resulted from infectious arthritis which he produced experimentally. The experimental work of Grey and Carr (1915) and of Allison and Brooks (1921) concerning the atrophy of bone which follows injuries of the large nerves of the extremity, that which occurs after changes in the vascularization of the part, and that type which follows prolonged immobilization, has added much to our knowledge concerning the factors which are responsible for this disturbance.

Turner (1924) reported osteoporosis following Colles' fracture and he pointed out the possibility of sensory nerve involvement. He observed that osteoporosis was more marked on the ulnar side of the hand; consequently he felt that injury of the dorsal interosseus nerve or the dorsal cutaneous branch of the ulnar nerve might have played a part in bringing about the atrophy of the bones.

Theories concerning etiology.—In all the recent work there has been no evidence that the disease is of an inflammatory nature as Sudeck originally supposed it to be. Vialleton (1922) failed to find any evidence of cellular infiltration of an inflammatory nature in any of the specimens of porotic bone which he examined histologically.

At the present there are two main hypotheses concerning the etiology of post-traumatic osteoporosis. The first is that the disease is the direct result of the trauma and that the changes in the bone are brought about by reflex action upon the trophicity or the vascularity of the bone. The second theory is that osteoporosis comes on indirectly and that it is due to inactivity or loss of functional stimulation.

Sudeck showed that the atrophy of inactivity was able to reach a very pronounced degree in amputation stumps, but both Sudeck and Kienböck felt that true osteoporosis comes on much more rapidly than could be explained on the basis of inactivity alone.

In 1913 Brandes studied this problem experimentally. He resected the tendon Achilles in order to immobilize the foot and then studied the density of the calcaneus at regular intervals after complete fixation of the foot by a plaster-of-Paris bandage. He showed that the atrophy of inactivity came on very early—just opposite to the findings of Sudeck and Kienböck. Brandes' results were similar to those obtained by Pillet in 1906.

In 1915 Grey and Carr made similar experiments, and they also showed that the atrophy of inactivity came on early. They concluded, however, that the atrophy was due to an absence or deficiency of the necessary functional excitation to the nutrition.

Allison and Brooks (1921) obtained similar results. The röntgenological pictures of the atrophy of bone which they produced in animals by inactivity showed the same characteristics as the atrophy of bone in man. They demonstrated the characteristic changes in the trabeculæ of the epiphysis of the bones, and they pointed out that the degree of atrophy was in direct proportion to the length of time of immobilization. The histological structure of the bones of experimentally produced osteoporosis was identical with that found in the porotic bones from man.

Guarini (1918) explained such osteoporosis on the loss of functional activity with the resulting state of anæmia of the member and a deficit in the calcium salts that were being brought to the bone by the blood-stream. The reports of Delorme (1916) concerning the condition of the bones of seven soldiers in whom severe shrapnel wounds necessitated the ligation of the principal artery of one extremity fail to substantiate that theory, since no röntgenological evidence of atrophy of the bones was ever noted in any of these patients. Allison and Brooks were unable to produce atrophy of bone experimentally by ligation of the principal artery of the extremity. Attempts have also been made to produce atrophy of bone experimentally by local venous congestion, but these experiments have also been unsuccessful.

The remaining theory concerning the etiology is that attributed to the lack of functional excitation of the bone. Dauriac (1919) states that the absence of axial thrust is able to bring about a rarefaction about the ends of fractured bones. In extreme cases he states that this rarefaction goes on to the production of a pseudoarthrosis. In final analysis it is difficult to determine the exact nature of this "axial thrust" or "functional excitation."

It is quite probable that trauma of the peri-articular tissues has, in some cases at least, played a definite rôle in the production of the rarefaction which was attributed to the immobilization by the plaster case. It is true that simple immobilization does not always produce an extensive atrophy of the bones so, perhaps, there are still other factors which play a part in bringing about the rarefaction in such instances. Clinically it is well known that extensive osteoporosis frequently comes on in patients whose extremities had never been immobilized.

Osteoporosis is relatively rare after fractures of the diaphysis of bones and quite common after trauma, with or without fracture, of the peri-articular or juxta-articular regions. Marked vasomotor changes of an extremity have been produced experimentally by Albert (1924) and by us (1927) after various kinds of injury to the peri-articular tissues. The fact that osteoporosis is still more frequent after trauma to the poly-articular regions such as the ankle or the wrist, is suggestive evidence that stimulation of the nu-

merous articular and peri-articular nerves brings about the vasomotor changes that are ultimately responsible for the production of the osteoporosis.

The oscillometric studies made by Professor Leriche in 1917 show that, in man also, peri-articular trauma is followed by a marked vasomotor disturbance in the extremity. Slight trauma to the poly-articular regions usually produces a very marked vaso-dilatation, but it may, on the contrary, produce a vaso-constriction. Leriche and Fontaine (1929) have shown that the traumatization frequently causes a block in the local circulation at the site of the injury. This block of the circulation may be caused either by marked vaso-dilatation or by marked vaso-constriction. It is this difference in the local reaction to the trauma that determines the various clinical pictures of this disease. It is generally thought that osteoporosis appears only after violent trauma, fracture of a bone, or some severe contusion of a joint. However, recent extensive studies have convinced us that marked osteoporosis may follow a very slight trauma to the soft tissues around a joint. The peripheral vascular disturbances associated with spasm of the surrounding muscles which was originally described by Babinski and Froment (1917) as "physiopathic troubles" has recently been shown to give rise to osteoporosis in the great majority of the cases.

In the early stages of osteoporosis there is always a local hypervascularization as shown clinically by the increased local temperature and the increase of the oscillometric index. The phenomena of vaso-constriction are uniformly found in the late stages of the disease. Leriche and Policard have studied the problem in detail, and they have shown that hyperæmia is a necessary factor for the absorption of bone.

We are of the opinion that true osteoporosis is the direct result of the hyperæmia produced by vasomotor changes that result from reflexes which originate in the traumatized area.

Site and frequency.—Osteoporosis is most frequently found in the short bones of the hands and feet. Next in order of frequency is the epiphysis of metatarsals, metacarpals and phalanges, and then the epiphysis of long bones. The diaphysis of long bones is rarely involved. The flat bones of the skull may also be the seat of similar rarefaction. Recently Schüller (1929) reported typical examples of post-traumatic osteoporosis of the skull.

Moreau-Gimelli (1912) and Delorme (1917) analyzed a total of 7400 röntgenograms which had been taken because of trauma to one or more of the extremities, and they found only 115 cases (1.5 per cent.) of atrophy of the bones. During the World War, Delorme reported sixty-two cases of osteoporosis from a series of 178 cases of trauma to bones, and later he analyzed 1350 additional röntgenograms of the same type. He concluded from these series of cases that osteoporosis existed in 50 per cent. of the cases where the trauma affected the small bones of the hands or feet; 20 per cent. after trauma to the distal phalanges and 50 per cent. of the cases in which both bones of the leg were fractured. In the cases of fracture of the bones of the forearm he concluded that one-third of the cases of fracture

of one bone and two-thirds of the cases in which both bones were fractured developed true osteoporosis. Guarini (1918) came to the same conclusions after studying a large series of röntgenograms. Such statistics, however, only show the number of cases which showed decalcification of the bones in the röntgenograms, and they do not take into consideration the equally important clinical signs of the disease.

Clinical forms.—In order to avoid all confusion with atrophy of inactivity or disuse we shall always refer to the bone atrophy that is associated with pain and vasomotor disturbances as the true osteoporosis. We distinguish four main forms of painful osteoporosis, namely: (a) The post-traumatic form. (b) The post-infectious form. (c) The form associated with nervous disorders. (d) The dystrophic form associated with disturbances of ovarian function.

In this paper we shall limit our discussion to the post-traumatic form. Sudeck differentiated between the reflex atrophy and the atrophy of inactivity, but since that time many investigators have referred to the two forms of bone atrophy as being identical.

True osteoporosis is always characterized by (a) *loss of motor function of the extremity*, (b) *characteristic changes in the röntgenograms*, (c) *the constant coëxistence of vasomotor disturbances*, and (d) *great pain*. The disturbances of the function are always more extensive than could be explained on the basis of the trauma alone, and the severe acute pain is greatly out of proportion with the local signs of injury to the tissues. If we disregard the local effect of the trauma we are still impressed by the great loss of motor function; the extreme constant pain and the marked vasomotor disturbances. Another almost pathognomonic symptom is that the pain is not relieved by immobilization, while the pain associated with simple trauma, fracture of one of the bones, or even tuberculous osteo-arthritis is definitely relieved by proper immobilization.

A very common clinical form of the disease of osteoporosis is frequently seen after fractures of the bones of the wrist or ankle which have been properly reduced. After the removal of the bandage at the end of two or three weeks the extremity is found to be swollen and discolored. Slight active or passive motion of the joint causes the patient great pain. Mechanotherapy, baking and massage make the pain more severe and the loss of function of the extremity continues to become worse. Such a clinical history is typical of true osteoporosis.

From the clinical point of view the extension of the functional disturbances beyond the area of traumatization and accompanied by constant pain which cannot be relieved by immobilization or physiotherapy is indicative of true post-traumatic osteoporosis. When the osteoporosis is limited to the bones of the foot the patient suffers very little pain while he is in bed, but he constantly complains that he is unable to bear weight on his foot because of pain.

Vasomotor disturbances.—The vasomotor and trophic disturbances ac-

companying osteoporosis were described by Sudeck. The association of osteoporosis with cyanosis; subjective and objective sensations of cold; œdema and trophic disturbances such as ulcerations, hyperkeratosis, atrophy of the skin and hypertrichosis; and constant pain have been repeatedly pointed out. Most of our cases have shown marked muscular atrophy, cyanosis of the extremity which is accentuated when the limb is placed in the dependent position, marked œdema and a thinning of the skin with a disappearance of all of the surface markings giving it a "glossy skin" appearance.

When the osteoporosis was limited to the bones of the hand most of our patients showed a hyperthermia of the affected side and occasionally this hyperthermia was very marked. In one case of osteoporosis of the bones of the shoulder the temperature of the dorsum of the hand on the affected side was 29.5°C ., while that of the normal side was 28.5°C . The measurements were made with a sensitive thermo-couple. The temperature of the affected shoulder was 34.2°C . and only 33.1°C . on the normal shoulder. In other cases, however, a slight hypothermia was found.

The oscillometric index is of great value in determining the existence of the vasomotor disturbances. In seven cases of osteoporosis of the bones of the wrist the oscillations were six times stronger in the affected forearm than at the same level in the normal forearm. In one case there was no difference between the two sides. In the upper arm the difference in the oscillations is usually less marked. In many cases where a definite difference in the oscillations existed in the forearms there was little or no difference in the upper arms.

Out of six cases of osteoporosis of the bones of the ankle we found a marked increase in the oscillations in the lower third of the affected leg in five cases. The difference in the oscillations in the thighs was always very small. In the other case of osteoporosis of the bones of the ankle the oscillations in the corresponding extremities were about equal.

In six cases of osteoporosis of the bones of the shoulder we found four cases with diminished oscillations in the forearm and arm of the affected side. One case showed a marked increase in the oscillations of both the arm and forearm of the affected side. The other case showed an increase in the forearm and a decrease in the upper arm of the affected side.

In osteoporosis there is always a stage in which there are local signs of vaso-dilatation (hyperæmia and increase in the oscillations). Later in the evolution of the disease these vasomotor disturbances may disappear or become modified in the opposite direction.

Röntgenological aspects.—Two main forms of osteoporosis have been described as showing constant and characteristic changes in the röntgenograms. Sudeck named these apparently distinct stages in the evolution of the disease the (a) acute form and (b) the chronic form.

(a) The so-called acute form is characterized by a mottled appearance of the bone due to the irregular rarefied areas in the spongiosa. This mottling is usually most marked in the carpal and tarsal bones and in the heads of the metacarpal and metatarsal bones. In advanced cases the cortex of the small

bones becomes very thin and the outline of the individual bones is frequently lost. The lamellæ fade into one another and produce an ill-defined or homogeneous shadow in the röntgenogram.

(*b*) In the so-called chronic form the trabeculæ of the bone are very fine and sometimes difficult to recognize. The limits of the individual bones again become demonstrable, but there still remains a general loss of calcium salts. The patchy areas of rarefaction are not present. The increased strength of the bone is due to a thickening of the longitudinal lamellæ since the horizontal lamellæ remain very thin.

In cases of osteoporosis of the short bones, especially the carpal and the tarsal bones, we recognize three stages in the evolution of the disease. These three stages are (*a*) the onset; (*b*) the height of the disease; and (*c*) the reorganization. We believe that each of these three stages present characteristic röntgenological changes. The evolution of the disease from the standpoint of röntgenological changes can best be portrayed as follows: In the period of onset, which Sudeck called the acute form of the disease, there is a general mottled appearance of bones in the röntgenogram. The outlines of the bones are still easily discernible. The rarefaction continues to become more marked and more extensive. The irregular areas of rarefaction soon disappear and the bones become uniformly permeable to the Röntgen-rays. This stage of diffuse and marked decalcification marks the height of the disease. The absorption of the bone seems to spread to the neighboring bones and thus involves the heads of the metacarpals or metatarsals, then the phalanges and finally the adjoining ends of the radius and ulna or the tibia and fibula as the case may be. Marked thinning of the cortex of the bones has taken place and longitudinal streaks have made their appearance in the thinned cortex. In the region of the carpal and tarsal bones this thinning of the cortex of the bones results in the disappearance of the limits of the bones and thus transforms the entire area into a homogeneous mass which is very permeable to the Röntgen-rays. It is at this stage that a diagnosis of tuberculous osteo-arthritis is frequently made. During the period of reconstruction there is a slow reappearance of the calcium in the bones. In most cases complete recalcification never takes place. Röntgenograms taken during this stage show that the limits of the small bones have again become visible and the longitudinal lamellæ have become thickened.

The duration of each of these stages is very variable. The factor of time seems to be of little importance. In general, however, the first two stages are relatively rapid in their evolution, while the third or reconstructive stage is usually extremely slow. Professor Leriche has observed one case in which the rarefaction of the bones of the foot persisted for more than fourteen years after the initial trauma. (Fig. 1.) It is certain that after a bone becomes rarefied to any great extent it rarely regains its original density; consequently the process of reconstruction must usually be considered as incomplete. Complete anatomical restoration of the density of the bone, however, is not necessary for complete symptomatic relief.

In cases of osteoporosis of the epiphysis of long bones the first stage of evolution passes rapidly and it is unusual to observe the patient early enough to find the typical mottled appearance of the bones in the röntgenogram. There is usually a marked thinning of the cortex and a diffuse rarefaction of the entire bone demonstrable in the röntgenogram.

Post-traumatic osteoporosis of the flat bones of the skull is rare. We have observed one case in which the mottled appearance of the bones was marked. We have not observed thinning of the cortex of the bones of the skull comparable to that which we have described for the short and long bones of the body.

Clinical evolution.—It is commonly thought that osteoporosis is a self-limited disease and that after a few weeks or months recalcification takes place without leaving any deformities. Vialleton and others have expressed such views. Sudeck states that favorable evolution is only occasionally seen, and it is not the usual end-result of this disease. Kienböck (1902) and Hofmann (1916) have expressed the same opinion.

It has been our experience that after the disease has reached the climax or stage of complete decalcification, the process of recalcification begins spontaneously. Years later, however, the röntgenograms still show the thinning of the cortex of the bones and the thin lamellæ containing irregular areas of recalcification. From these facts one might get the impression that the disease heals spontaneously since it is also well known that all the vasomotor disturbances and pain frequently disappear without treatment. In the untreated cases, however, the recovery of function of the extremity requires many years and frequently during the stage of recalcification extensive fusion of the carpal or tarsal bones takes place. This ankylosis may cause great economic loss to the patient.

The following case history is presented as a typical example of the end result of osteoporosis of the bones of the foot which was allowed to continue untreated.

CASE I.—A single, white woman, aged thirty-seven years, was seen in consultation by Professor Leriche in July, 1928, because of constant dull, aching pains in the left foot and an inability to bear weight on that foot. In 1914, about fourteen years previously, she "sprained" her left ankle while on a hunting expedition. The injury was apparently not very severe since she continued to walk throughout the day without much discomfort. During the night that followed she complained of moderately severe throbbing pains in the ankle-joint but no attempt was made to immobilize the extremity. She continued to walk about without aid but the pain in the ankle caused her to limp most of the time. For years after the accident she said her ankle remained "sensitive." Slight trauma to the ankle always caused great pain. During the subsequent fourteen years she consulted several physicians and almost invariably she was told she had tuberculous osteo-arthritis of the ankle. No methodic treatment had ever been instituted as she had always refused the proposed surgical form of treatment.

Physical examination in 1928 showed the patient in good general health. Local examination of the feet showed no evidence of vasomotor disturbances. There was a slight swelling of the left ankle with some tenderness to pressure over the tarsq-

metatarsal joints. There was a subastragaloid ankylosis with the left foot in the talipes equinus position. Röntgenograms showed a diffuse rarefaction of all the small bones of the left foot. There was a fusion of the calcaneus and the cuboid; and between the scaphoid and the cuneiform bones. (Fig. 1.)

In this patient the osteoporosis of the bones of the foot evolved over a period of fourteen years and without ever having had the foot immobilized. During the entire time the patient suffered almost continuous pain and she was considerably incapacitated. Examples of this type are not rare. The knowledge of the slow evolution of osteoporosis



FIG. 1.—Röntgenogram showing post-traumatic osteoporosis which had evolved over a period of fourteen years. (Case 1.) Destruction of the joint surfaces between the tarsal bones and between the tarsal and metatarsal bones can be seen.

and the extensive ankylosis that frequently results should constitute an added indication for the prompt and thorough treatment of this disease.

Diagnosis.—In general painful osteoporosis can be divided into three main clinical groups depending upon the type of trauma which precipitated the disturbance. The differential diagnosis is somewhat different in each of these groups since the clinical course of the disease is frequently altered by the in-

tensity of the trauma and the extent of the injury to the bones or to the articulations.

In the case of osteoporosis which follows slight or moderate trauma to one of the poly-articular regions, wrist or ankle, little importance is usually attached to the original trauma. Gradually, over a period of weeks, the patient develops pain on moving the extremity and vasomotor disturbances of the entire extremity slowly make their appearance. Limitation of motion in the neighboring joints then becomes the outstanding symptom. The functional disability increases in severity and the pain is made worse by immobilization of the affected part. The differential diagnosis between osteoporosis and tuberculous osteo-arthritis must then be made. The röntgenological evidence of a diffuse decalcification without the slightest evidence of a specific focus is against a diagnosis of tuberculosis. However, the great majority of our cases had had a diagnosis, at one time or another, of tuberculous osteitis or arthritis.

In the second group, namely those in which the injury of the articular or peri-articular tissues is associated with a fracture of one or more of the bones of that extremity, the trauma is immediately considered as the major cause for the pain and local vasomotor changes. Since such injuries are regularly treated by complete immobilization in splints or plaster-of-Paris cases one must always consider the possibility of atrophy of inactivity. Whenever an extremity continues to show evidence of vasomotor disturbances associated with limitation of motion and pain in the neighboring or involved joints after the proper reduction of the fracture the most probable cause for such a disturbance is a diffuse osteoporosis and röntgenograms should be taken at once to establish the correct diagnosis.

In the third group, namely those in which the trauma is slight and limited to the soft parts around the joint one must rule out the possibility of a low-grade myositis or chronic teno-synovitis as the cause for the constant pain since spasm of the muscles of the extremity, slight tenderness of the muscles or tenderness in the region of the joint may be the only physical evidence of disease. In cases of osteoporosis the patient complains of great pain on motion of the extremity. The röntgenogram may confirm the diagnosis for osteoporosis in this stage of evolution shows a very definite diffuse mottling of the bones of the extremity. In this type of case the vasomotor disturbances are very slight if present at all. We believe this mild form of osteoporosis should be treated in the same manner as the more severe forms of this disease.

Pathology.—Gross examination of the porotic bones show them to have a very thin, brittle cortex and a medulla that is almost completely replaced by adipose tissue. In the later stages of the disease the vascularization is markedly reduced.

Comparatively few studies of the microscopic structure of the porotic bones have been made. Vialleton (1922) has reported histological examinations of the bones in two cases of osteoporosis. He examined the metatarsals

and the astragalus and found a disappearance of all the transverse striæ of the bones with a diminution of the longitudinal striæ (lamellæ). The atrophy was not uniform. In very late cases only a few dense, irregular acellular areas remain within the large medullary spaces. The Haversian canals become greatly enlarged without causing corrosion of the lacunæ. The cortex becomes very thin and the vessels undergo marked thickening which results in a diminished vascularization of the bone.

The mechanism of this absorption of bone has been described by Volkmann as being brought about in two different ways. First, removal by the so-called osteoclasts and, secondly, by the process of halisteresis or osteolysis of Kilian.

The first method of osteoclastesis is dependent upon the phagocytic action of special cells called "osteoclasts" by Kölliker. In the cases examined by Vialleton and in our own cases, these specific phagocytes were not seen in any of the preparations which were examined.

The second method of osteolysis is based on the discovery that the disappearance of osseous tissue may take place without the apparent intervention of cellular elements. The progressive diminution of the spongy medullary bone; the enlargement of the Haversian canals; and the thinning of the cortex of bones without the presence of osteoclasts seems, to us at least, to represent more accurately the mechanism of the production of osteoporosis.

The exact chemical phenomena which bring about this disappearance of osseous tissue are still unknown. Professor Leriche has presented the various theories regarding the resorption of bone in his recent work on the normal and pathological physiology of bone which was done in corroboration with Professor Policard. The chemical examinations made by Pech (1920) and Pradal (1921) show that the mineral content of porotic bone is relatively the same as that of normal bone; consequently they conclude that there is a uniform loss of bony substance in osteoporosis and not merely a depletion of the mineral salts of the bones.

From the standpoint of the pathological picture it has been shown by Grynfeldt (1921) and again by Vialleton (1922) that the "fatty osteoporosis" described by Cornil and Ranvier is identical with the post-traumatic osteoporosis.

Treatment.—The treatment of osteoporosis has, until recently, been symptomatic and preventative rather than curative in nature. Sudeck recommended minimum immobilization and then active movement in most of his cases. Nobel and Hauser (1926) recommended heat to the point of tolerance either in the form of radiant heat or paraffin baths. They also advised massage and voluntary motion of the joints in spite of a little pain, but they emphasized that forceful manipulation under anæsthesia was definitely contra-indicated. Any form of fixation with plaster-of-Paris casts or orthopædic apparatus causes increased pain to the patient. Delorme recommended treatment by thyroid and para-thyroid extracts and Pech advised heliotherapy.

All of these forms of therapy still left much to be desired. The course of

the disease was only slightly shortened and the unfavorable sequelæ were about as frequent as when the process was left untreated.

In 1924 Heyman performed the first peri-arterial sympathectomy for osteoporosis. About the same time Professor Leriche also performed a peri-arterial sympathectomy as the surgical treatment of osteoporosis. The therapeutic result was striking.

It is difficult to explain the mechanism by which this improvement is brought about since the operation of sympathectomy should be contra-indicated in a disease which is caused by hypervascularity of the extremity. The sympathectomy produces an added vasodilatation and hyperæmia. The clinical fact remains, however, that improvement can be obtained equally well in cases of osteoporosis with vaso-dilatation as well as those with vaso-constriction as the dominant clinical sign.

Since 1924 all cases of osteoporosis admitted to the clinic of Professor Leriche have been treated by sympathectomy and the results have been so gratifying that we feel that the method with our complete results is worthy of being placed on record.

REPORT OF CASES.—The first two cases of this series are especially interesting because we had an opportunity of studying the histological changes that took place in the porotic bone after the sympathectomy.

CASE II.—G. M., married, white, farmer, aged fifty-seven years, was admitted to hospital August 21, 1929, because of a swollen, painful, discolored right hand. All the joints of the right hand were stiff. The past history showed that on April 29, 1929, a cow stepped on the patient's hand. The hand became swollen and remained so in spite of vigorous medical treatment. After a few weeks the joints of the hand became stiff and a constant dull pain in the hand and wrist made its appearance. Vasomotor disturbances in the form of cyanosis and more œdema gradually came on over the entire right hand and wrist. There was an average difference of one centimetre between the circumference of corresponding fingers on the two hands. The affected hand was two centimetres greater in circumference than the normal hand. Slight motion of the thumb remained while all the other joints of the right hand were immovable. There was no evidence of fractures in any of the bones in the röntgenogram but there was a marked diffuse, irregular or patchy decalcification of the bones. (Fig. 2.) Oscillations were increased in the right forearm.

On August 23, 1929, the stellate (cervico-thoracic sympathetic ganglion) together with the intermediate ganglion of the right side were removed. Examination made several hours after the operation showed that the œdema had completely disappeared, the hand was very warm and the skin was of the normal pink color. The movements of the fingers were free and the motion was not painful. Moderate motion of the wrist. Examination on the following day showed some diminution of the movements of the fingers and wrist. During the next two days the cyanosis returned and the movements of the fingers again became limited; consequently on August 27 a peri-arterial sympathectomy of the right brachial artery was performed. This operation was followed by a return of the movements of the fingers associated with moderate hyperæmia of the entire hand and arm. The following day the patient developed an acute alcoholic psychosis and had to be transferred to the psychopathic ward. He died in acute delirium tremens about three weeks later.

At autopsy several of the carpal bones were removed from each wrist for histological examination. There were gross and microscopic changes in the bones from the right



FIG. 2.



FIG. 3.



FIG. 4.

FIG. 2.—Röntgenogram taken four months after an injury of the right hand. The patchy decalcification of the bones is characteristic of the early stage in the evolution of post-traumatic osteoporosis. (Case II.)
 FIG. 3.—Photomicrograph showing the histological structure of the carpal bones during the stage when the patchy decalcification is so marked as in Fig. 2. (Case II.) (x 200.)
 FIG. 4.—Röntgenogram taken six months after an extensive injury to the right shoulder. The diffuse and uniform decalcification is characteristic of the fully developed post-traumatic osteoporosis. (Case III.)

hand. The lamellæ were fairly thick. (Fig. 3.) Osteoblasts were present along the lamellæ. A few osteoclasts were found in small lacunæ in the lamellæ. Evidences of construction of bone seemed to dominate the picture. The bone marrow was very fatty and poor in myelogenous elements. Very thin-walled blood vessels were grouped around the masses of myeloid tissue. There were several islands of fibrous tissue between the lamellæ and separated from the bone by a layer of osteoblasts. It is, of course, impossible to directly attribute all of these changes toward the construction of bone to the sympathectomy. The circumstantial evidence is striking and it remains for us to carry out similar studies on a large series of cases in order to determine the exact changes brought about by the sympathectomy.

CASE III.—O. K., married, white, laborer, aged fifty-seven years, was admitted to the hospital January 15, 1930, because of a swollen, painful and discolored right hand. His past history showed that on October 31, 1929, during the course of his work, he received a severe blow on the right shoulder. Fracture of the right scapula, clavicle and several ribs resulted from that trauma. About three weeks after the accident he noticed a burning sensation in the fourth and fifth fingers of the right hand. These pains were relieved by immersing the hand in cold water. The pains gradually spread to the entire right hand, forearm and shoulder. At the same time there developed stiffness of all the joints of that extremity.

Physical examination showed a slight Claude Bernard-Horner syndrome on the right side. Moderate atrophy of the muscles of the right arm. The right hand and forearm were cyanotic and œdematous. The skin of the hand was smooth and shiny. Slight increase in the local skin temperature of the right hand. Manipulation of the slightest degree of the hand or arm caused severe pains in the entire arm and shoulder. All movements of the extremity were markedly restricted. Only slight abduction of the right shoulder was possible. Complete extension of the right elbow was impossible and motion, active or passive, of the elbow-joint was very painful to the patient. Slight flexion and extension of the wrist. Pronation and supination greatly limited. Slight movements of the fingers were possible but painful. The oscillations as recorded by the Pachon oscillometer were much greater in the right than in the left forearm. Röntgenograms showed well-consolidated fractures of the right clavicle and scapula. There was a marked decalcification of the head of the humerus; of the epiphyses of the bones in the region of the elbow; and of both bones of the forearm. The rarefaction of the carpal and metacarpal bones was still more marked. (Fig. 4.)

January 18, 1930, Professor Leriche attempted to perform a resection of the stellate ganglion and the inferior part of the cervical sympathetic chain. There was an extensive sclerosis of the tissues at the base of the neck which was probably the result of the organization of an old and extensive hæmatoma. The vertebral artery was identified but it was found impossible to dissect out and identify either the sympathetic chain or the stellate ganglion. A small mass of tissue was removed from behind the vertebral artery. Histologically this tissue showed some nerve fibres with ganglion cells imbedded in a mass of dense fibrous tissue. Because of the incompleteness of this operation Professor Leriche performed a peri-arterial sympathectomy of the right brachial artery on January 21, 1930.

After the second sympathectomy the pain in the hand and elbow disappeared but the pain in the shoulder remained unchanged. The mobility of the fingers and wrist was greatly improved but the limitation of motion in the shoulder-joint remained the same.

Since the pain persisted in the right shoulder Professor Leriche felt that it was advisable to attempt the removal of the superior part of the dorsal sympathetic chain on the right side. The posterior approach was used and the second rib and part of the first rib were removed. The same dense fibrous tissue was found in the region of the dorsal sympathetic chain. It was impossible to identify the individual ganglia; consequently only section of the sympathetic chain could be done with any degree of accuracy.

Histologically the tissue which was removed showed many nerve fibres and a few scattered ganglion cells imbedded in dense fibrous tissue.

Following this operation there was considerable improvement in the mobility of the shoulder-joint and a diminution of the pain in the shoulder and in the upper arm. At the time of discharge from the hospital on April 23, 1930, there was fairly good motion of the fingers and elbow but only slight motion in the shoulder-joint. The patient still complained of moderate pain in the right shoulder and upper arm.

In July, 1930, the patient returned to the hospital because of a bilateral empyema which had apparently come on after a severe upper respiratory infection. Surgical drainage was instituted, but the patient continued to become worse and finally died.

At autopsy a bilateral confluent broncho-pneumonia was found in addition to the extensive subacute empyema. We were especially interested in the condition of the

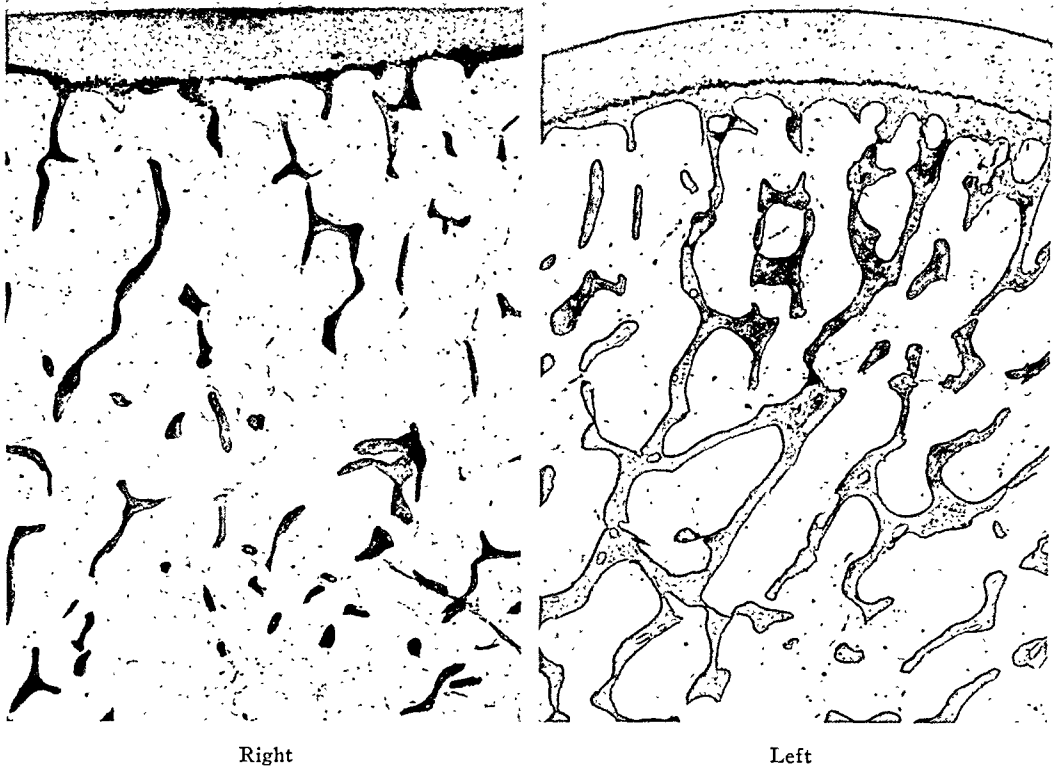


FIG. 5.—Photomicrographs showing the difference in the histological structure of a carpal bone from the right hand, in which there was röntgenological evidence of fully developed osteoporosis, and the histological structure of the corresponding carpal bone from the opposite hand. (Case III.) Compare with Fig. 3. (x 100.)

bones in the right arm and hand; consequently the head of the humerus and several carpal bones were removed from each side for histological study. The bones of the right hand showed extensive and marked osteoporosis. The histological preparations showed fewer and thinner bony lamellæ in the bones of the right hand. (Fig. 5.) The bone marrow was almost entirely made up of adipose tissue. There was no evidence of hypervascularization in this case probably because this was a late stage of the disease. The process of osteoporosis in this case appeared to be one of pure osteolysis. Very little evidence of repair was found in any of the preparations which we examined. The lack of signs of reconstruction of bone might be attributed to the fact that complete sympathectomy was impossible due to the extensive sclerosis in the region of the sympathetic ganglia.

Osteoporosis of the bones of the hand and wrist following simple trauma

POST-TRAUMATIC OSTEOPOROSIS

to the peri-articular or juxta-articular tissues. In this series of cases the trauma was not severe enough to cause a fracture of any of the bones.

CASE IV.—J. F., single, white, laborer, aged seventeen years, entered the hospital November 11, 1924, because of a painful swelling of his left hand with marked limitation of motion in the wrist-joint. The past history showed that during the six months prior to admission he had noticed that his left arm became fatigued after slight exertion. Two weeks before admission to the hospital he was suddenly taken with a severe pain in his left wrist while he was attempting to lift a block of iron. Motion of the wrist remained painful and he noticed moderate swelling of the dorsum of his hand.

Examination at the time of entry to the hospital showed a marked œdema of the entire left hand with almost complete fixation of the wrist-joint. There was marked



FIG. 6—Röntgenograms showing the condition of the carpal bones before and after peri-arterial sympathectomy in a case of diffuse post-traumatic osteoporosis. (Case IV.)

A—One month after injury of the left hand.

B—Two and one-half months after the sympathectomy.

tenderness of the carpal bones to light palpation. There was a pronounced atrophy of all the muscles of the forearm. The röntgenogram showed an irregular rarefaction of all of the carpal bones causing a loss of the outline of some of the carpal bones. (Fig. 6A.) A diagnosis of tuberculous osteo-arthritis was made and the extremity was immobilized in a plaster-of-Paris case. This fixation made the pain and swelling so much greater that the case had to be removed. In December, 1924, Professor Leriche examined the patient and found that there was an increase in the vascularization of the left forearm and hand. The oscillations were greater in the left forearm than in the right. (Fig. 7.) After these examinations he felt that the entire clinical picture together with the röntgenological findings was characteristic of post-traumatic osteoporosis.

December 10, 1924, a peri-arterial sympathectomy of the left brachial artery was performed. A plaster case was then applied to the forearm. The pain disappeared soon after the operation. December 25 the case was removed and the patient was able to move his wrist freely without pain. The œdema had also disappeared. A new plaster-of-Paris case was applied and the patient was discharged from the hospital. A short time later the patient removed the case without consulting his family physician.

Follow-up examination of February 20, 1925, showed him to be entirely free from

pain or swelling of the wrist. The movements of the left wrist were normal. The atrophy of the muscles of the left forearm remained unchanged. Röntgenogram taken February 23 showed considerable recalcification of all of the carpal bones of the left

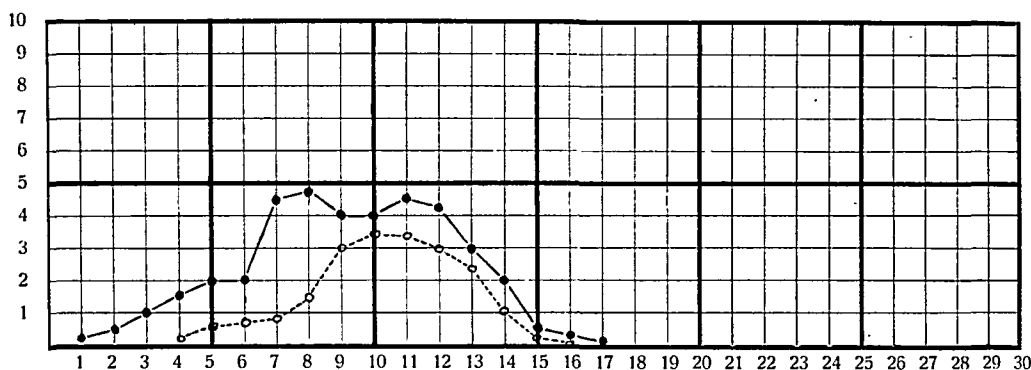


FIG. 7.—Comparison of the oscillometric readings from the forearms. (Case IV.) Readings from the left forearm are represented by a solid line while those from the right forearm are shown by the interrupted line.

wrist. (Fig. 6B.) April 20 he reported that he had been working regularly without the slightest pain or feeling of fatigue in his left arm or hand. He enlisted in the French Marine Corps April 25, 1925. In March, 1928, he reported that he was well and had no trouble with his arm or wrist.

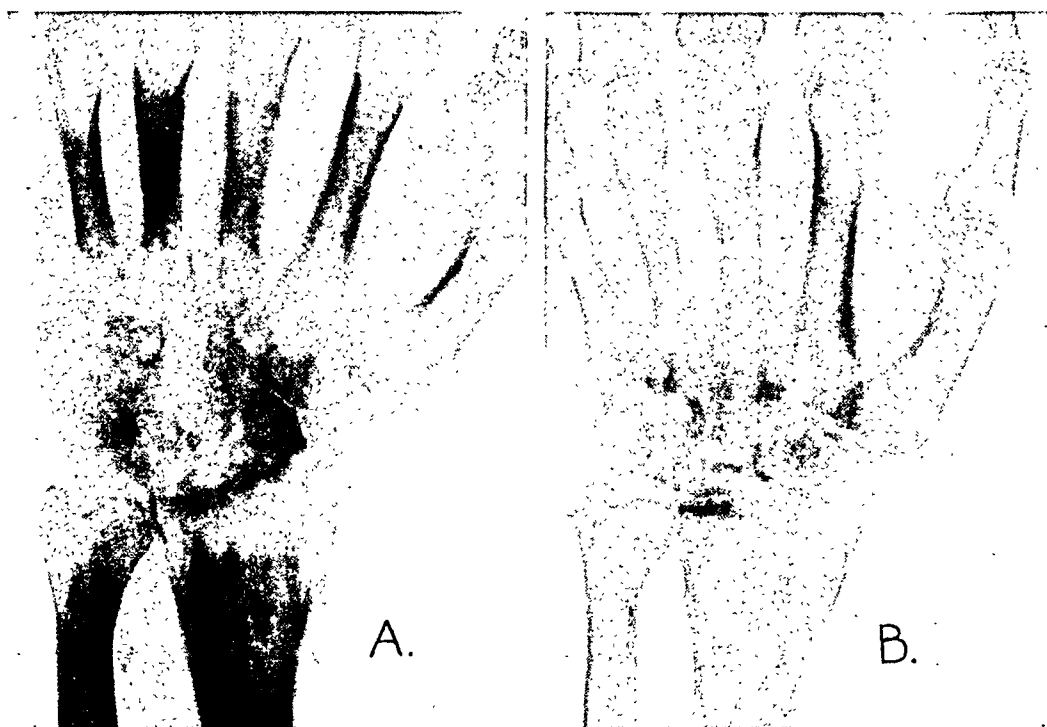


FIG. 8.—Röntgenograms showing unfavorable evolution of the osteoporosis in spite of sympathectomy. Complete ankylosis of the wrist-joint with only partial recalcification of the bones was the ultimate result. (Case V.)

A—Marked osteoporosis six months after the trauma.

B—Ultimate anatomical result five years after the trauma.

CASE V.—F. W., married, white, laborer, aged forty-seven years, entered the hospital September 11, 1924, because of painful swelling of his left hand. The past history showed that June 2, 1924, he slipped and struck his left hand against a wagon.

POST-TRAUMATIC OSTEOPOROSIS

Immediately after this accident he began to have severe pains in the left wrist and hand. Swelling of the hand gradually came on and within two days all motion in the wrist-joint was lost. Rest, massage and hot baths failed to give relief from the pain.

On admission to the hospital about three months after the accident there was marked swelling of the wrist and cyanosis of the forearm and hand. Only slight flexion and extension of the wrist was possible. Motion of the wrist-joint was painful. Movements of the fingers were limited and the muscles of the forearm and arm were atrophied. Röntgenogram showed marked decalcification of all the bones of the left hand. The limits of the individual carpal bones could no longer be made out. (Fig. 8A.) A diagnosis of tuberculous arthritis was made and on September 24, 1924, the arm was immobilized in a plaster-of-Paris case. This immobilization made the pain much worse; consequently the case was removed. Oscillations were increased in the left forearm. (Fig. 9.) Professor Leriche was asked to see the patient. After a complete examination he felt that the clinical findings together with the röntgenological changes in the bones were typical of post-traumatic osteoporosis and he, therefore, advised a peri-arterial sympathectomy as the treatment.

November 21, 1924, a peri-arterial sympathectomy of the left brachial artery was performed. There was a marked diminution of the swelling within the first forty-eight hours after the operation. The pain on motion of the wrist disappeared. December 9,

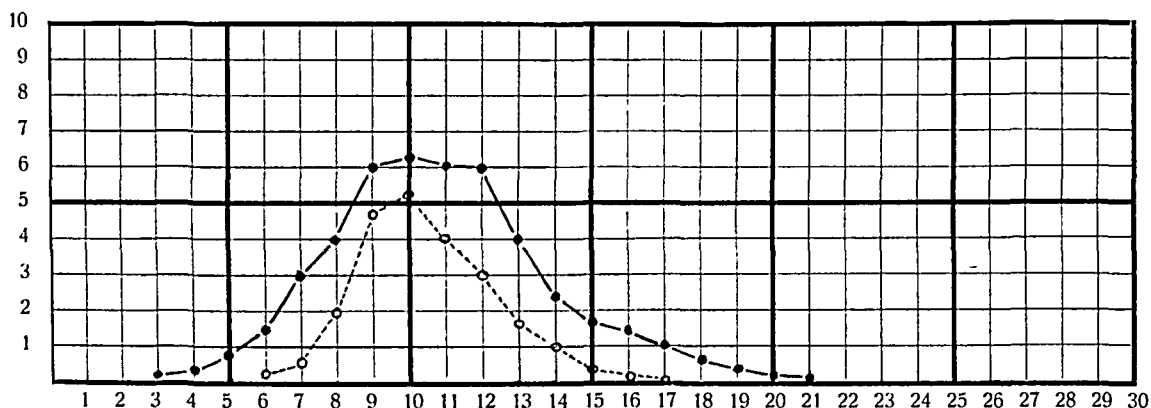


FIG. 9.—Curves showing the oscillometric readings in the right and left forearms. (Case V.)
Solid line represents the left forearm.

1924, the movements of the fingers were normal, but the motion of the wrist remained limited. Another plaster-of-Paris case was applied and immobilization was continued for three months longer. At the end of that time the range of motion of the fingers was normal. No improvement in the motion in the wrist-joint. The surface temperature of the left hand was greater than that of the right. Röntgenograms showed that recalcification was taking place slowly but there was also evidence of destruction of several of the carpal bones with extensive fusion of the bones of the wrist. (Fig. 8B.) The patient was seen at fairly regular intervals over a period of more than five years after the operation. The motion of the fingers remained normal. No œdema of the hand, vasomotor disturbances of the extremity nor pain on motion of any of the joints had ever appeared since the sympathectomy. He has been able to continue his work as a laborer without interruption since the removal of the plaster-of-Paris case three months after the sympathectomy.

CASE VI.—M. Mo., married, white, housewife, aged fifty-four years. This patient entered the hospital on January 11, 1928, because of painful swelling of her right wrist. The past history showed that on October 22, 1927, while at work in the fields, she twisted her right wrist. This caused severe pain in the entire right hand associated with numbness of all the fingers. She left her work immediately and in spite of complete rest and hydrotherapy the functional difficulties increased in severity. A short time later she noticed a marked increase in the swelling of the hand with progressive stiffness of the wrist.

On entrance to the surgical dispensary (polyclinic) about five weeks after the accident examination showed an atrophy of all of the muscles of the right arm. The right wrist was swollen and deeply cyanotic. Röntgenograms showed a marked decalcification of all the carpal bones with some involvement of the distal ends of the radius and ulna and the proximal ends of the metacarpals. There was a loss of the inter-articular spaces between the carpal bones. (Fig. 10A.) A diagnosis of tuberculous arthritis was made and a plaster-of-Paris case was applied to the arm and hand. The immobilization was continued for about six weeks in spite of the fact that the pain was made worse by the plaster bandage.

January 11, 1928, Professor Leriche examined the patient and in view of the circulatory disturbances, changes in the bones as shown by the röntgenograms and the clinical course of the disease he felt that a diagnosis of post-traumatic osteoporosis should be made.

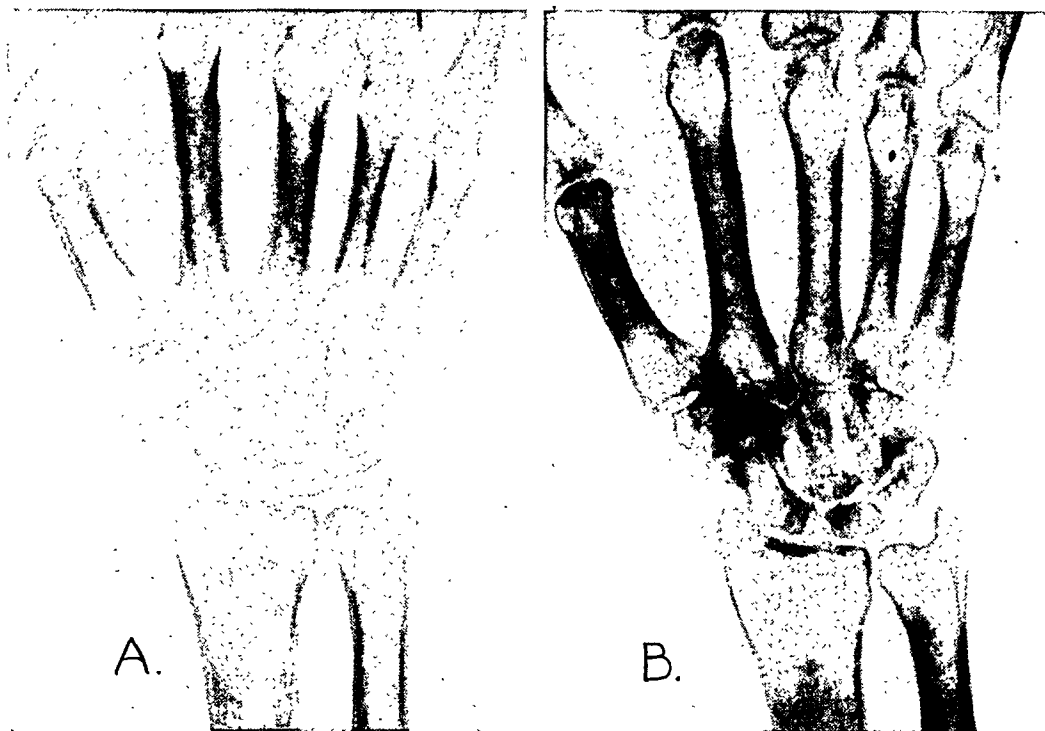


FIG. 10.—Röntgenograms showing the effect of peri-arterial sympathectomy upon post-traumatic osteoporosis which had already reached the height of the disease. (Case VI.) Recalcification has taken place very slowly.

A—Three months after simple torsion of the right wrist.

B—Two years after peri-arterial sympathectomy.

January 14, 1928, a peri-arterial sympathectomy of the right brachial artery was performed. Immobilization by plaster was continued after the operation. The pain disappeared immediately. Examination after the removal of the plaster on the fifteenth post-operative day showed an absence of the oedema and a marked increase in the motion of the fingers and wrist.

Follow-up examination April 4, 1928 (six months after the sympathectomy) showed only slight limitation of motion of the fingers and wrist. No circulatory disturbances nor oedema present. Considerable recalcification of the bones of the wrist had already taken place. February 26, 1930, twenty-five months after the sympathectomy, examination showed normal range of motion of the fingers and wrist. No pain on movement of the joints and no evidence of circulatory disturbances. Röntgenograms showed more recalcification but the process was still not complete. (Fig. 10B.) This case shows that complete recalcification is not necessary for complete symptomatic relief to the patient.

POST-TRAUMATIC OSTEOPOROSIS

Osteoporosis of the bones of the hand following trauma which was of sufficient intensity to cause a fracture of one or more of the bones in the vicinity of the wrist-point.

CASE VII.—M. E., married, white, housewife, aged fifty-nine years, was referred to the hospital October 1, 1928, because of painful swelling of the right hand and wrist. The past history showed that on July 20, 1928, the patient fell on the outstretched arm causing a typical Colles' fracture. Immediately reduction under anæsthesia put the bones in perfect anatomical position. The entire extremity was immobilized for five weeks. Massage and "electrical treatment" were then instituted. In spite of all treatment the hand remained swollen, discolored and stiff. Röntgenograms showed a diffuse mottling of all the carpal bones with some rarefaction of the distal ends of the radius and ulna and

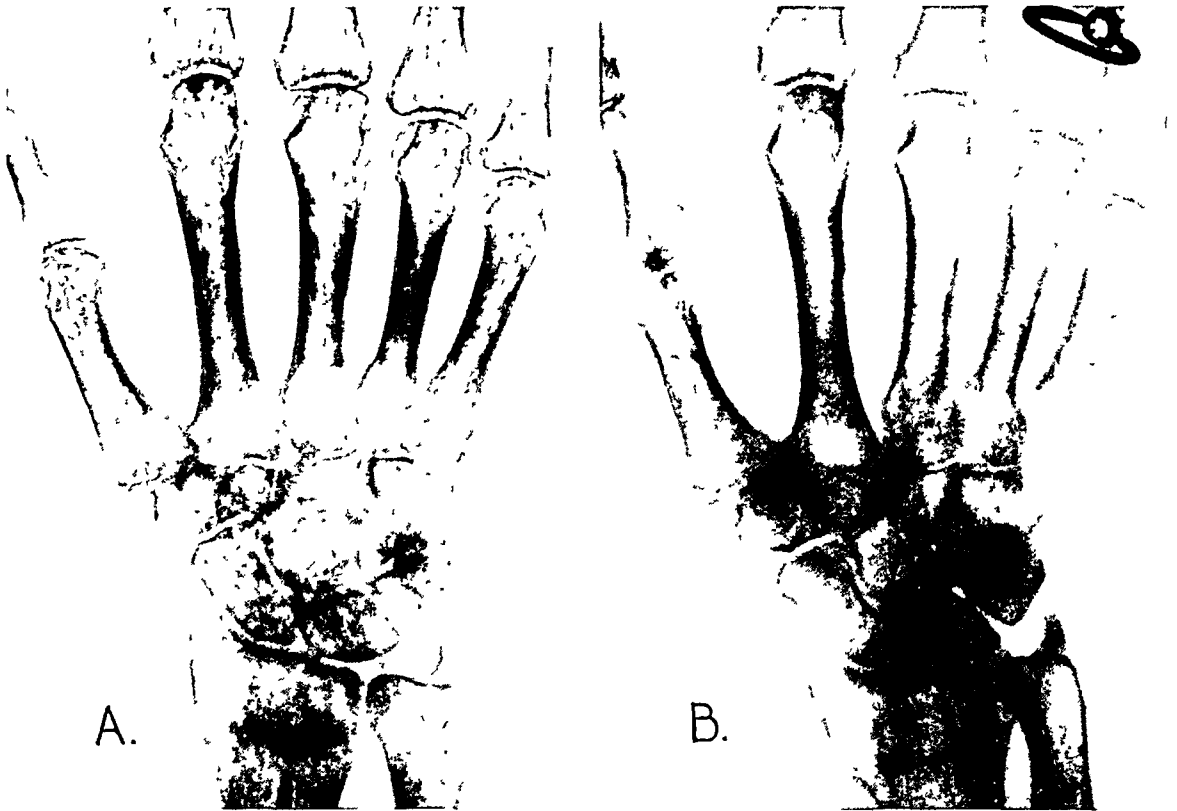


FIG. 11.—Röntgenograms showing the effect of peri-arterial sympathectomy upon post-traumatic osteoporosis which was still in the early stage of evolution. (Case VII.)

A—One month after the Colles' fracture.

B—Two months after the peri-arterial sympathectomy.

moderate mottling in the heads of the metacarpals. (Fig. 11A.) The oscillations were increased in the right forearm.

The patient was referred to Professor Leriche and he performed a peri-arterial sympathectomy of the right subclavian artery October 3, 1928. The post-operative course was uneventful. During the four weeks that followed there was a noticeable increase in range of motion of the fingers. The cyanosis and œdema had disappeared.

Repeated follow-up examinations have shown a constant improvement in the movements of the fingers. Six months after the sympathectomy, examination showed full range of motion of the fingers and the wrist. No pain on motion of any of the joints. She stated that the strength of her right hand was still below normal nevertheless she was able to do all her housework without difficulty or fatigue. Röntgenograms taken at that time showed almost complete recalcification of the bones of the right hand and wrist. (Fig. 11B.)

CASE VIII.—M. Te., married, white, housewife, aged sixty-five years, entered the

hospital November 8, 1928, because of severe pain in the right forearm associated with swelling and discoloration of the right hand. September 3, 1928, she had sustained a Colles' fracture (Fig. 12A). Reduction was done under anæsthesia and fair alignment of the fragments was obtained. The first plaster-of-Paris bandage was removed after five days and the hand was put up in abduction and extension. When this case was removed after two weeks it was found that the patient could not move her wrist or her fingers. Pronation and supination of the hand was also impossible. The patient then began to have violent, shooting pains which started in the fourth and fifth fingers and radiated to the elbow. Massage, "electrical treatments," and the application of moist heat failed to give any relief. This loss of function could not be explained on the basis of a poor reduction of the fractured bones. Slight adduction and abduction of the thumb could be done with difficulty. The entire hand and forearm were cyanotic. There was increased local heat associated with pitting œdema of the dorsum of the right hand. Oscillations were increased in the right forearm (Fig. 13). Röntgenograms showed an extensive osteoporosis of the carpal bones, the radius and ulna and the metacarpal bones. There was a marked thinning of the cortex of all of these bones. (Fig. 12B.)

November 8, 1928, a peri-arterial sympathectomy of the right brachial artery was performed. The fractured bones were manipulated slightly and then immobilized by plaster-of-Paris. The pain disappeared immediately. When the plaster case was changed November 17 the movements of the fingers was found to be much better and the œdema and cyanosis had also disappeared.

Follow-up examination March 17, 1929, over four months after the sympathectomy, showed a normal range of motion in the wrist and in the joints of the fingers. Moderate degree of pronation and supination possible. No pain on motion of any of the joints. Röntgenograms showed that the recalcification of the bones of the hand was taking place slowly. (Fig. 12C.)

CASE IX.—M. R., married, white, housewife, aged forty-one years. This patient entered the hospital November 26, 1927, because of constant severe pains in her right wrist associated with œdema and cyanosis of the hand and forearm. The past history showed that October 1, 1927, she fell down a stairway and fractured the distal end of the right radius. The fracture was reduced immediately. After four weeks of immobilization in plaster-of-Paris the callus did not appear to be very firm; consequently further immobilization by a crinoline bandage was carried out. About one week later the patient began to complain of pain in the right wrist. During the subsequent two weeks the pain gradually increased in severity.

Examination at the time of admission to the hospital showed an enormous swelling of the right hand and forearm. All the joints of the fingers were stiff. Oscillations were increased in the upper third of the right forearm. Surface temperature of the dosum of the right hand was 33.4° C. as compared with 30° C. on the left. Röntgenograms showed the fractured bones to be in good position and well consolidated but there was an extensive osteoporosis of all of the carpal bones.

On November 23, 1927, a peri-arterial sympathectomy of the right brachial artery was performed by Professor Leriche. Immediately after this operation the pain in the wrist disappeared, and the œdema slowly diminished. There was a rapid return of the motion in the wrist and joints of the fingers.

Follow-up examination May 10, 1928, over five months after the sympathectomy, showed that the clinical improvement was lasting. No further pain or œdema and all circulatory disturbances had disappeared. There remained only slight limitation of pronation. Recalcification of the wrist and hand was taking place slowly.

Osteoporosis of the bones of the hand and wrist associated with vasomotor disturbances and marked spasm of all of the muscles of that extremity following trauma of slight or moderate intensity.



Fig 12.—Röntgenograms from Case VIII showing the fracture produced by the trauma, the diffuse osteoporosis that developed subsequently, and finally the rapid recalcification that followed the trauma, the diffuse osteoporosis that developed subsequently, and finally the rapid

A—Colles' fracture resulting from a fall (September 3, 1928).
 B—Marked osteoporosis of all the bones of the hand two months later.
 C—Recalcification almost complete four months after the sympathectomy.

CASE X.—L. S., married, white, housewife, aged sixty-five years, entered the hospital June 15, 1925, because of stiffness of the left shoulder and elbow-joints associated with attacks of pain in the entire left arm. Five months previously she was knocked down by a bicyclist. The only physical evidence of injury from the fall was a small, superficial wound on the dorsum of the left hand. This wound healed promptly without showing any signs of infection. About one month after the accident she noticed stiffness of the joints of the fingers of the left hand. This stiffness grew progressively worse and soon after there was noticeable stiffness of the wrist-joint, elbow-joint and finally shoulder-joint. The patient then began to complain of sharp pains in the left hand and arm.

At the time of admission to the hospital there was a marked spasm of all of the muscles of the arm and moderate atrophy of the scapular group of muscles. The scapulo-humeral joint was immovable, and attempts at passive motion of the upper arm caused excruciating pain to the patient. Movement of the scapula permitted the arm to be raised a slight amount. Complete extension of the elbow-joint was impossible. The joints of the fingers were so stiff that the patient could not close her hand. Complete neurological examination was normal. Electrical stimulation of the nerves and muscles of the left arm gave normal reactions. Professor Leriche felt that in view of the negative neurological examination and the positive röntgenological evidence of decalcification of the bones of the left arm that a diagnosis of diffuse osteoporosis due to axone reflexes of

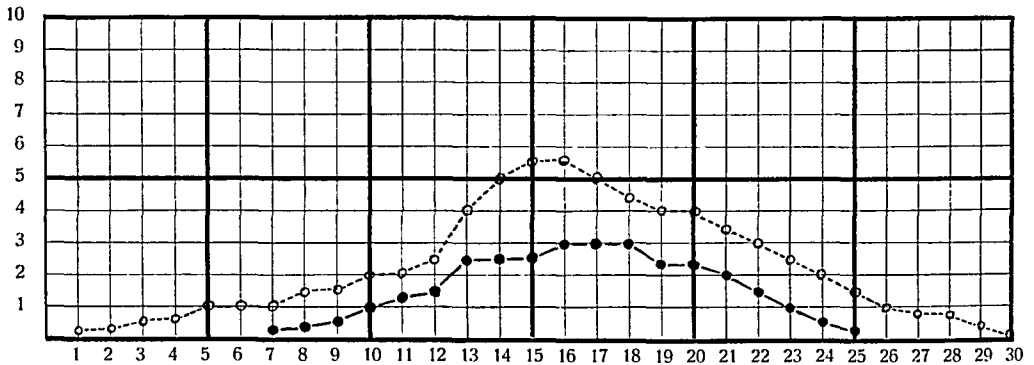


FIG. 13.—Curves showing the oscillometric readings in the right and left forearms. (Case VIII.) Solid line represents the left forearm.

traumatic origin was justifiable. He suggested cervical ramisection as the treatment of choice.

June 19, 1925, Professor Leriche exposed the cervical sympathetic chain through an incision at the base of the neck just above the left clavicle (novocaine anaesthesia). The four rami communicantes of the stellate (cervico-thoracic ganglion) were then isolated, identified and finally sectioned. That evening the constriction of the left pupil and enophthalmos of the left eyes were very marked. The surface temperature of the dorsum of the left hand was 1.9° C. higher than that on the opposite hand. The pain in the arm had disappeared. Movements of the fingers were improved. Increase range of motion in the left elbow-joint. June 28, nine days after the cervical ramisection, complete extension of the forearm was possible without pain. The left hand could be closed. Passive motion of the upper arm produced no pain but the scapulo-humeral joint remained almost completely fixed.

Repeated follow-up examinations showed a constant improvement in the mobility of the shoulder, elbow, wrist and interphalangeal joints. In December, 1930, five and one-half years after the operation, examination showed that the patient had regained the full range of motion in the shoulder-joint. The hand could be closed tightly and she had been free from all pain or discomfort in the left arm. The recovery was complete. Röntgenograms showed considerable recalcification yet all of the bones of the left arm and hand remained less dense than the corresponding bones of the opposite side.

Osteoporosis of the bones of the foot and ankle which appeared after simple trauma to the peri-articular or juxta-articular tissues. In this series of cases the trauma was not sufficient to produce a fracture of any of the bones.

CASE XI.—J. Ko., married, white, coal-miner, aged forty-five years, was brought into the hospital November 28, 1925, because of an injury to the left foot. Examination showed an extensive contusion of the left ankle but no physical or röntgenological evidence of fracture of any of the bones. The entire leg was immobilized in a splint and the patient was kept in bed. After three weeks he attempted to bear weight on the left foot. This caused so much pain that it was necessary to immobilize the foot again. The condition of the foot remained about the same and he was unable to walk for many months. He slowly improved sufficiently to bear weight on the foot. He was discharged from the hospital May 10, 1926.

He was unable to return to work because his left leg would become completely fatigued after short walks or after standing for some time. Some time later he began to have dull aching pains in the left ankle and foot. Sometime in September, 1926, he was referred to a private hospital where a peri-arterial sympathectomy of the left formal artery was supposed to have been done. Following this operation the pains in the foot and ankle grew worse and he was finally referred back to the University Hospital.

On the second admission to the surgical clinic on November 20, 1926, he complained of violent pains in the left ankle and radiating along the inner aspect of the leg. Pains were aggravated by walking. The muscles of the left leg were atrophied. There was marked cyanosis of the left foot and leg. Röntgenograms showed an extensive osteoporosis of all the bones of the left foot and ankle.

November 22, 1926, about one year after the original injury, Professor Leriche performed a left lumbar sympathetic ramisection by the extraperitoneal route. An intense hyperæmia of the left leg and foot followed this operation. The pains disappeared immediately. Within a few days the œdema and cyanosis had also disappeared. On the sixteenth post-operative day the patient walked without aid and without pain. Gradual improvement followed and he was discharged from the hospital on the twenty-first post-operative day.

Follow-up examination three months later showed complete return of the movements of the leg and ankle and no pain. Recalcification of the bones of the ankle was almost complete at that time. March 28, 1927, four months after the ramisection, the patient stated that he had no further pain and that he had returned to his regular work in the coal mines.

CASE XII.—G. K., married, white, laborer, aged twenty-seven years, was admitted to the hospital April 13, 1928, because of severe pains in the left ankle associated with marked swelling of the entire foot. On March 21, 1928, he had fallen from a roof and landed on the heel of his left foot. The foot became swollen immediately. Four days later he noticed a "black and blue" discoloration of the skin over the entire left ankle and extending a short distance up the leg. The œdema of the foot slowly diminished but he was unable to bear weight on the foot because of the violent pains in the ankle.

Examination showed moderate œdema of the dorsum of the left foot. The muscles of the left leg were slightly atrophied. Slight limitation of extension of the left foot. Pressure over the tarsal bones and over the heads of the metatarsals caused great pain. Röntgenograms showed marked osteoporosis of tarsal bones and the heads of the metatarsals. Oscillations were strong on both sides.

April 21, 1928, a peri-arterial sympathectomy of the left femoral artery was done. The pain disappeared almost immediately. Follow-up examination about six months later showed that the patient was able to walk normally and without the slightest pain. Röntgenograms showed almost complete recalcification of the bones of the ankle and foot.

CASE XIII.—E. Tr., married, white, laborer, aged twenty-five years, was referred to

the hospital October 8, 1929, because of swelling of the left ankle and an inability to walk because of pain in the left foot. In August, 1929, a beam of wood fell on his left foot. The foot became swollen and painful immediately but he was able to continue his work. About two weeks before admission to the hospital he suddenly noticed sharp pains in the left ankle. That evening on leaving the street-car he twisted his ankle and following this slight accident he was unable to bear weight on that foot. The next morning his foot was greatly swollen and very painful. Medical treatment failed to give relief so he was sent to the hospital.

On admission to the hospital there was marked œdema and cyanosis of the left foot and lower leg. The foot was warm and the oscillations were increased in the left lower leg. Pressure over the third tarso-metatarsal joint was painful. Röntgenograms showed irregular zones of rarefaction in the heads of the third and fourth metatarsal and in the cuneiform bones. A diagnosis of tuberculous osteitis was made and the foot was immobilized in a boot-type plaster-of-Paris case. The pain was not relieved by this immobilization. Rarefaction of the tarsal bones continued until the limits of these bones could no longer be seen. A diagnosis of osteoporosis was finally made.

December 12, 1929, a peri-arterial sympathectomy of the femoral artery was performed. The œdema and cyanosis disappeared very quickly. By the following day all the pain had disappeared. The movements of the toes were free and painless. Röntgenograms taken at the end of January, 1929, showed a moderate amount of recalcification.

Follow-up examination in April, 1930, four months after the sympathectomy, showed no signs of œdema or cyanosis of the left foot. The movements of the ankle were normal and painless and the patient was able to walk normally.

CASE XIV.—C. H., married, housewife, aged thirty-nine years, was admitted to the hospital October 15, 1930, because of pain, swelling and limitation of motion of the right ankle-joint. In June, 1930, she injured her right heel by jumping from a chair to the floor. The ankle became swollen and painful. Röntgenograms failed to show any evidence of fracture of the bones of the ankle or foot. The swelling and tenderness of the ankle persisted; consequently she was referred into the hospital.

On examination there was œdema and cyanosis of the entire right foot. Tenderness over the entire heel of the right foot. Röntgenogram showed a small "spur" of the calcaneus which had formed since the accident. The foot was immobilized for two weeks but no relief from the pain was obtained. In November, 1930, examination showed limitation of the movements of the ankle. Cyanosis was still present. All movements of the foot were painful. Oscillations were strong in both legs and greater in the right thigh than in the left. Röntgenograms taken at this time showed a mottling of all of the bones of the right foot and ankle and a diffuse decalcification of the calcaneus. (Fig. 14A.)

November 15, 1930, a peri-arterial sympathectomy of the right femoral artery was done. Marked hyperthermia of the leg and foot followed that operation. The pain was diminished in intensity but not completely relieved. The patient was able to bear her weight on the foot several days after the operation. On the fifteenth post-operative day she was able to walk unaided but she still complained of pain in the foot. Röntgenograms showed very little evidence of recalcification.

Follow-up examination in April, 1931, showed that the movements of the right foot were normal and the patient walked normally and without pain. Only slight recalcification of the bones has taken place during these five months since the operation. (Fig. 14B.)

CASE XV.—S. W., married, white, housewife, aged twenty-seven years, was admitted to the hospital June 1, 1926, because of severe pains in her right foot. Several months previously she had had a slight trauma to the right ankle but not sufficient to cause any severe pain or inconvenience at the time. Patient denied any history of venereal diseases.

Examination showed moderate œdema of the right ankle and foot with an extreme blanching of the entire distal part of that extremity. Pressure over the tarsal bones caused severe pain. Röntgenograms showed a diffuse osteoporosis of all of the bones of

POST-TRAUMATIC OSTEOPOROSIS

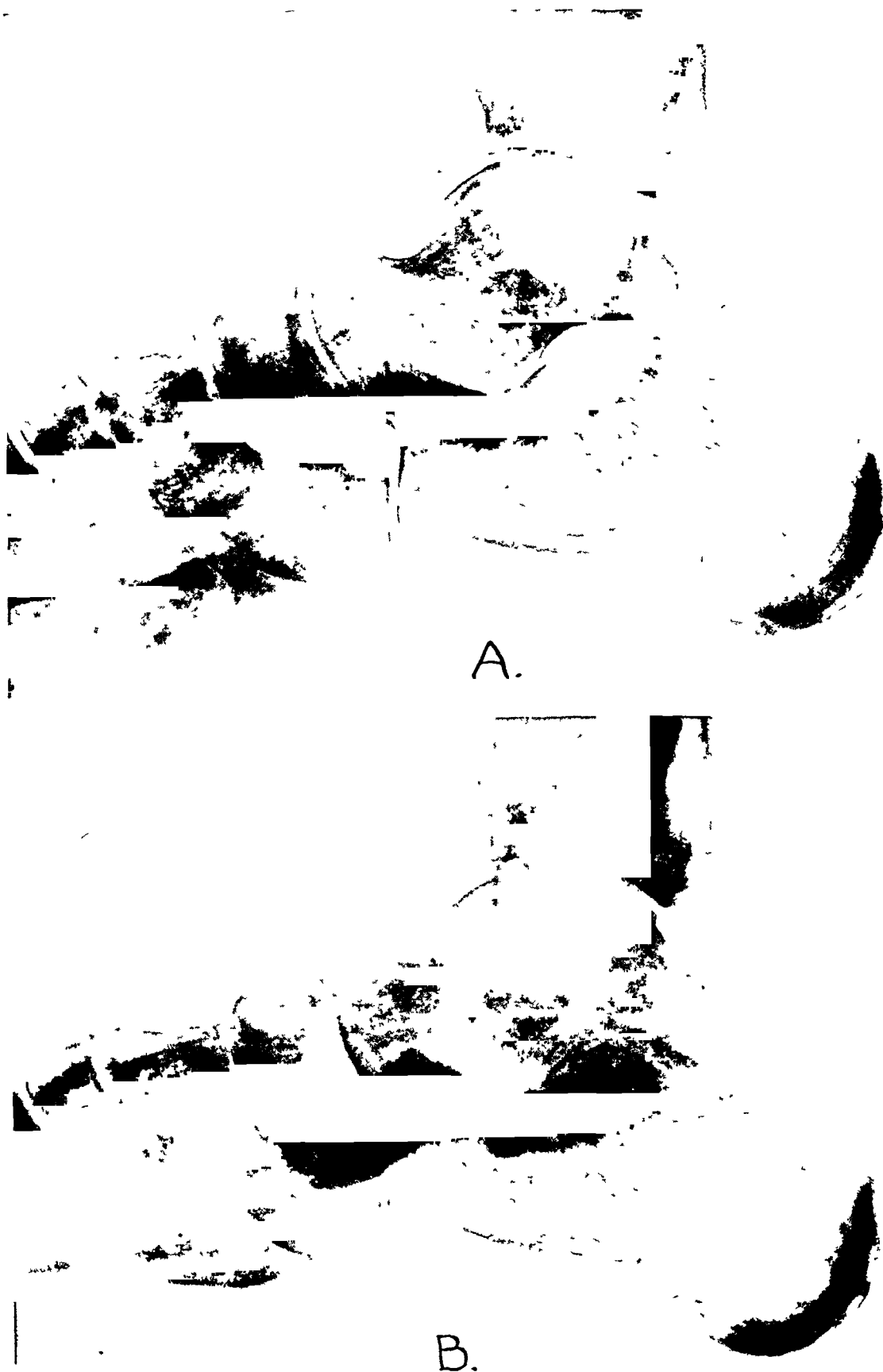


FIG 14.—Röntgenograms showing moderate decalcification of the bones of the right foot following simple trauma to the ankle (Case XIV)
A—Four months after the injury.
B—Five months after the peri-arterial sympathectomy.

ankle, foot and inferior third of the right leg. Gonorrhœal arthritis was suspected but the patient denied all signs of an acute gonorrhœal infection and repeated cervical and urethral smears were negative for intra-cellular diplococci. The foot was immobilized in plaster-of-Paris until November, 1926. Röntgenograms at that time showed a more diffuse osteoporosis with thinning of the cortex of the tarsal and metatarsal bones. A diagnosis of post-traumatic osteoporosis was then made.

On November 20, 1926, a peri-arterial sympathectomy of the femoral artery was done. The foot was then again immobilized in plaster-of-Paris. The case was changed January 18, 1927, at which time motion of the ankle-joint was only slightly painful and the color of the foot had returned to normal.

Follow-up examination May 26, 1927, showed the patient to be without pain or discomfort and she was able to walk normally. In April, 1930, three and one-half years after the sympathectomy, examination showed no signs of the former disease of the ankle. She walked normally and without pain or fatigue. Motion of the ankle-joint was still limited. Röntgenograms showed moderate recalcification and fusion of several of the tarsal bones.

CASE XVI.—J. B., married, laborer, aged thirty-eight years, was operated upon in May, 1926, because of an ingrown toe-nail of the right great toe. The wound became badly infected and suppuration continued for many weeks. When the wound finally healed the patient began to have sharp pains in the heel and on the lateral aspect of the right foot. Hot soaks, baking and massage failed to relieve the pain. On the contrary the pain gradually became worse and finally extended up the leg as high as the knee. The patient was admitted to the surgical clinic August 27, 1926. Examination showed a cyanosis of the right leg and foot. The muscles of the right leg showed moderate atrophy. The oscillations were greater in the right leg. The röntgenograms showed a diffuse decalcification of all of the bones of the right foot including the lower ends of the tibia and fibula.

September 2, 1926, a peri-arterial sympathectomy of the femoral artery was done. There was immediate relief of the pain in the leg and foot. The following day brought a return of some pain and this slight dull pain continued for about six weeks. The pain then gradually disappeared and there has never been a return of any type of pain or discomfort.

Follow-up examination November 14, 1928, over two years after the sympathectomy, showed normal motion of the ankle-joint. No evidence of atrophy of the muscles of the right leg at that time. Gait was normal. The right foot was decidedly warmer than the left and the oscillations were still slightly greater on the side where the sympathectomy was done. Röntgenograms showed the density of the bones of the two feet to be the same.

Osteoporosis of the bones of the foot and ankle following trauma which was of sufficient intensity to cause a fracture of one or more of the bones in the region of the angle-joint.

CASE XVII.—P. Vo., married, white, housewife, aged thirty-one years. On January 11, 1928, the patient fell and twisted her ankle in such a way as to cause a typical Pott's fracture on the left. There was no displacement of the fragments according to the röntgenograms; consequently the entire foot and leg was immobilized in plaster-of-Paris. No manipulation was necessary. At the end of five weeks the plaster was removed. She was unable to walk because of severe pains in the ankle and foot. Baking, massage and diathermy failed to bring about any improvement. The pains became so severe that the patient had to go to bed since the pain was relieved when the foot was kept at rest. In attempting to walk she struck the left great toe on a chair and caused a fracture of the distal phalanx. The röntgenograms taken on April 8, 1928, showed a very patchy decalcification of the small bones of the left foot. (Fig. 15A.) A diagnosis of tubercu-

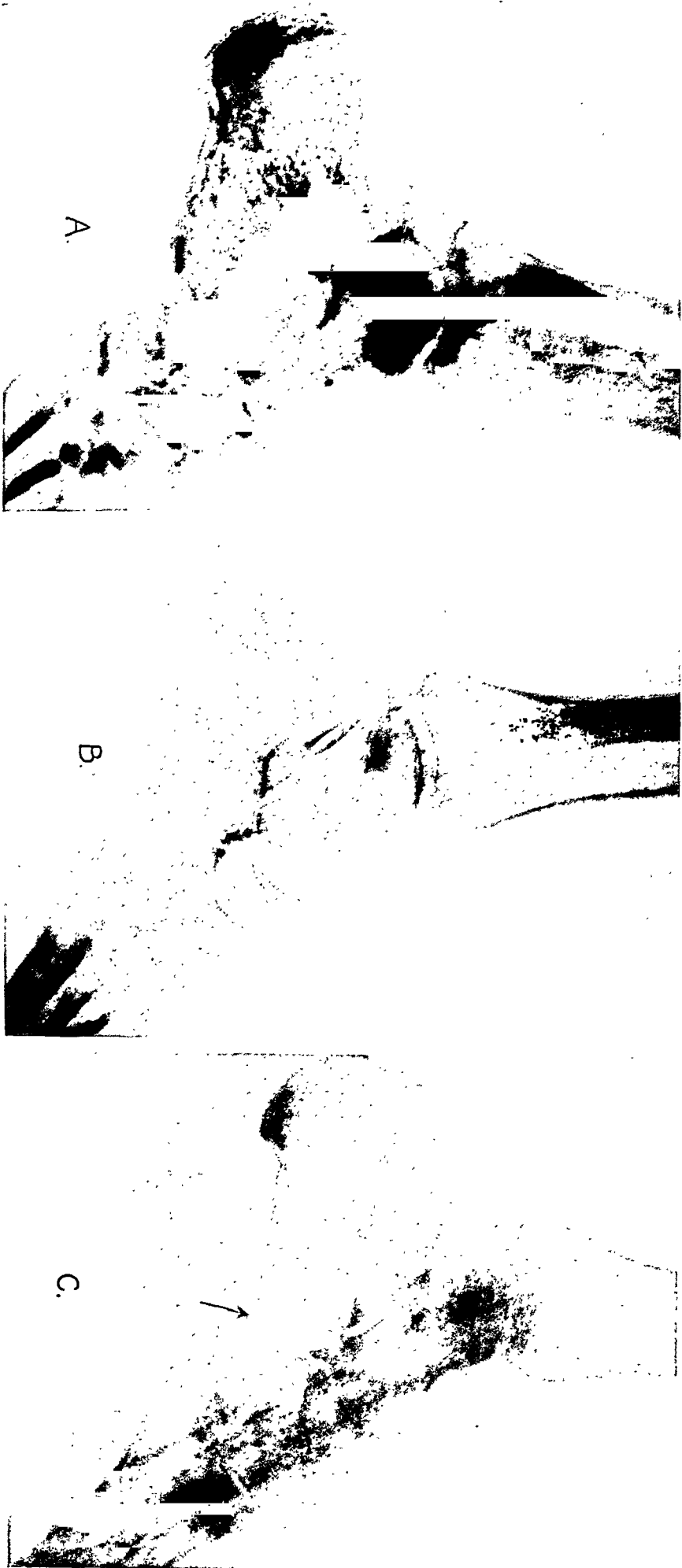


FIG. 15.—Röntgenograms showing the evolution of post-traumatic osteoporosis before and after peri-arterial sympathectomy. (Case XVII.)
A—Three months after a Pott's fracture.
B—Four months after the fracture and just before sympathectomy.
C—Seven and one-half months after the sympathectomy.

lous arthritis was made. Professor Leriche⁴⁵ was asked to see the patient in consultation. Examination showed a slight œdema of the left foot, limitation of motion in the ankle-joint and limitation of motion of the toes. Passive motion of the sub-astragaloid joint caused great pain. The röntgenograms taken in May, 1928, showed extreme decalcification of all of the bones of the left ankle. The cortex of the bones was greatly thinned but the limits of the individual bones could still be made out. (Fig. 15B.)

May 5, 1928, Professor Leriche performed a peri-arterial sympathectomy of the left femoral artery. The œdema and pain disappeared very rapidly. The movements of the foot were much freer and entirely painless at the time of discharge from the hospital May 19.

Follow-up examination July 16, 1928, about two and one-half months after the sympathectomy, showed that the patient was able to walk without aid but she still had slight pain in the left ankle-joint. Recalcification was taking place slowly but by December 18, 1928, the recalcification was nearly complete. (Fig. 15C.) The patient was again seen in July, 1929, at which time she was able to walk normally but slight pain in the ankle-joint still persisted.

Osteoporosis of the bones of the shoulder.—This variety usually presents the clinical picture of traumatic arthritis. The changes in density of the head of the humerus are much more difficult to recognize. Professor Leriche has shown that extensive changes in the articulations may take place after trauma and the subsequent hyperæmia. The results following sympathectomy are usually very striking in these cases; consequently we wish to present the following typical cases and the results which we have obtained by this method of treatment.

CASE XVIII.—C. Pf., single, white, laborer, aged fifty-six years, entered the hospital October 22, 1927, because of constant pain in the right shoulder with almost complete fixation of the shoulder-joint. In May, 1926, he was struck on the right shoulder by a heavy block of lead which fell from a height of about six feet. He continued to work in spite of considerable pain in the entire shoulder. About three weeks later the pain suddenly became worse and he noticed a constant decrease of the motion in the shoulder-joint.

At the time of admission to the hospital all movements of the right arm were extremely painful. There was a slight atrophy of the muscles of the right shoulder. Loss of strength of the right hand and forearm. Only slight voluntary motion in the right shoulder-joint possible. The oscillations were greatly increased in the right upper arm. Röntgenograms showed definite decalcification in the head of the right humerus.

On October 31, 1926, Professor Leriche⁴⁵ performed a peri-arterial sympathectomy of the right subclavian artery together with an exploration of the shoulder-joint. The joint capsule was greatly thickened. The synovial membrane was villous and the cartilage of the head of the humerus was slightly roughened and a few irregular reddened areas were found in the cartilage. Biopsy of the cartilage and synovium was made.

The improvement was rapid and by November 3 most of the pain in the shoulder had disappeared and the patient was able to raise his right arm to the horizontal position without great pain. He was discharged from the hospital November 12, 1926.

Follow-up examination on December 20, 1926, showed that he was able to raise his arm to the vertical position without pain. He returned to work in December, 1926. Frequent examinations after that time showed no return of the former symptoms. He has continued to work without interruption.

CASE XIX.—C. Fr., married, white, laborer, aged fifty-seven years, entered the hospital April 17, 1928, because of severe pain in the right shoulder associated with marked restriction of motion of the shoulder-joint. In 1923 the patient fell from a

POST-TRAUMATIC OSTEOPOROSIS

bicycle and dislocated the head of the right humerus. The dislocation was reduced immediately after the accident. No further trouble until March 24, 1928, when he fell from a lumber wagon and again injured the right shoulder. The upper part of the right arm and the entire shoulder became swollen and motion in the shoulder-joint became greatly restricted. The functional disturbances gradually became worse.

Examination showed marked limitation of all the movements of the shoulder-joint. Passive rotation of the right arm was extremely painful. There was slight œdema of the right shoulder but there were no signs of vasomotor disturbances present. Röntgenograms showed no evidence of fracture of any of the bones in the region of the shoulder but there was a slight decalcification of the head of the right humerus.

Treatment by diathermy was carried out for several weeks but the symptoms continued to become worse in spite of the treatment. A few days later vasomotor disturbances were present in the upper part of the right arm. The cyanosis soon involved the forearm and hand also. There was a slight increase in surface temperature of the right forearm. The oscillations were increased in the right forearm but decreased in the upper arm. Surgical treatment by sympathectomy was proposed but the patient refused the operation and left the hospital.

June 26, 1928, the patient returned to the hospital because the pain and stiffness of the shoulder-joint had gradually but progressively grown worse. A periarterial sympathectomy of the right subclavian artery was performed on June 30, 1928. There was an immediate partial relief of the pain with considerable improvement in the motion of the right upper arm. The patient was discharged from the hospital July 12, 1928. The movements of the right arm were greatly improved but the patient still complained of moderate pain in the shoulder.

Follow-up examination in August, 1928, showed that all the former signs and symptoms had returned. In July, 1929, the pains in the right shoulder and the limitation of motion in the shoulder-joint were about the same as before the operation. In this case only moderate temporary relief was obtained from the peri-arterial sympathectomy.

CASE XX.—L. J., married, white, wood-chopper, aged fifty-one years, entered the hospital January 14, 1928, because of pain in the left shoulder with limitation of motion of the left upper arm. In 1914 he injured his left shoulder. Following that accident he had constant pain in that shoulder for over three months. The pain then disappeared slowly without treatment. He remained well until December 10, 1927, when he was struck on the left side of his body by a falling tree. Two ribs of the left side of the chest were fractured by this blow and the left shoulder was badly contused. After three weeks' rest in bed he began to have sharp pains in the left shoulder. Immobilization of the arm and shoulder aggravated the pain. Marked limitation of motion of the arm gradually took place. Pressure over the peri-articular tissues of the left shoulder-joint caused severe pain to the patient. Cyanosis of the left arm and shoulder then developed. The oscillations were diminished in the upper arm on the left side. Röntgenograms showed no evidence of fracture of any of the bones in the region of the left shoulder-joint. There was a marked rarefaction of the head of the left humerus.

January 16, 1928, Professor Leriche⁴⁵ performed a peri-arterial sympathectomy of the left subclavian artery. The pains in the left shoulder disappeared immediately and the range of motion in the shoulder-joint was greatly increased. Three weeks after this operation the patient returned to his work as a wood-chopper.

Follow-up examination May 16, 1928, four months after the operation, showed no limitation of motion in the left shoulder-joint and no pain. The patient had been working regularly.

CASE XXI.—C. Kr., married, white, farmer, aged thirty years, was admitted to the hospital June 17, 1929, because of severe pain in the left arm and shoulder associated with marked cyanosis of the entire extremity. February 14, 1929, he was caught between two wagons and a crushing injury of the left shoulder and chest resulted. The patient spat up blood-tinged sputum for about ten days. The pain in the left shoulder increased

in severity and the motion in the shoulder-joint became progressively more limited. The pain became so severe that he was unable to sleep. Treatment by baking, massage and diathermy was carried out for over four months without much relief of the pain or stiffness in the joint.

At the time of admission to the hospital there was atrophy of all of the muscles of the left shoulder and arm. Intense cyanosis of the entire left arm was present. The oscillations were diminished in the left upper arm. The left arm could only be raised to the horizontal position. Rotation of the arm was impossible. Passive motion of the arm caused great pain to the patient. Röntgenograms showed no evidence of fracture of any of the bones in the region of the left shoulder-joint. There was moderate rarefaction in the head of the left humerus.

June 28, 1929, a peri-arterial sympathectomy of the left subclavian artery was done by Doctor Fontaine. Intense hyperæmia of the hand and arm resulted but there was no improvement in the movements of the arm. The pain remained unchanged. Repeated follow-up examination showed no improvement followed the operation in this case.

CASE XXII.—L. M., married, white, laborer, aged thirty-five years, was referred to the surgical clinic from the neurological clinic on June 3, 1929, because of severe pain of the causalgic type in the scar of a war-wound in the right fronto-temporal region, together with severe pains in the right shoulder and limitation of motion of the right upper arm. In 1918 he was wounded by a shrapnel. The wound was in the right fronto-temporal region and it extended down to and included the right eye. The eye was removed immediately. Suppuration of the wound lasted for months but finally healing took place and a large irregular scar remained.

In March, 1929, he fell from a wagon and injured his right shoulder. Following that injury he gradually developed pain in the shoulder and arm with progressive limitation of the motion in the shoulder-joint. At about the same time he began to have pain in the scar on the side of his head. The pains in the scar increased in severity very rapidly and by June, 1929, they were so severe that he was unable to sleep.

Examination showed a marked cyanosis of the right arm and hand. Active rotation of the right upper arm was impossible. All active or passive motion of the right arm caused great pain to the patient. The oscillations were diminished in the right forearm.

Because of the intolerable pain in the scar on the side of the head it was felt advisable to treat that disturbance first; consequently on June 13, 1929, the right superior cervical sympathetic ganglion was removed by Doctor Fontaine. The pains in the scar ceased immediately after the operation. The pains in the right shoulder seemed to have been made worse by this operation upon the cervical sympathetic chain. Röntgenograms of the shoulder showed no evidence of fracture of any of the bones but there was a marked rarefaction of the head of the right humerus.

June 30, 1929, a peri-arterial sympathectomy of the right subclavian artery was performed by Doctor Fontaine. Following this operation the pain disappeared immediately but there was only slight improvement in the motion of the right upper arm.

Follow-up examination on January 10, 1930, showed no further improvement in the motion of the right arm but all the pain in the arm, shoulder and scar on the side of the head had been completely relieved by the operations. In spite of the limitation of motion of the right upper arm the patient was able to return to work.

SUMMARY

After an analysis of the results obtained in all of the cases of post-traumatic osteoporosis admitted to the surgical clinic of Professor Leriche since 1924, it is evident that the sympathectomy has added greatly to the comfort of the patient as well as having brought about the restoration of function much quicker than could possibly have taken place without the

POST-TRAUMATIC OSTEOPOROSIS

operation. However, in cases in which there is an advanced stage of the disease, the sympathectomy frequently gives only partial relief of the pain and little or no improvement in functional disturbances.

In the group of osteoporosis of the bones of the wrist we have reported nine cases. Two of these cases died from other causes shortly after the operation. Six of the remaining seven patients were completely relieved of all symptoms and functional disturbances. In one case of extensive osteoporosis of long standing the sympathectomy relieved the pain, but almost complete ankylosis of the wrist-joint was the ultimate anatomical result.

In the group of osteoporosis of the bones of the ankle we have reported seven cases. Four of these cases showed prompt and complete recovery. Two of the cases showed marked improvement in the function of the extremity, but a slight amount of pain persisted after the sympathectomy. One case has been operated upon recently; consequently no comment as to the end-result can be made at this time.

In the group of osteoporosis of the bones in the vicinity of the shoulder-joint we have reported five cases. Two of these cases showed prompt and complete relief after the sympathectomy, while the other two cases showed only slight improvement following the operation. One patient was completely relieved of the pain, but the stiffness of the shoulder-joint remained unchanged.

The type of operation upon the sympathetic nervous system that is to be used is determined entirely by the extent of the osteoporosis. In cases where the disease is limited to the bones of the ankle or wrist simple peri-arterial sympathectomy of the brachial or femoral artery, as the case may be, is sufficient. However, when all of these bones of an extremity are involved, the operation of sympathetic ramisection or ganglionectomy should be done. The surgical technic for these various operations is now well established.

CONCLUSIONS

(1) Post-traumatic osteoporosis is a disease entity with characteristic röntgenological changes in the three main stages in the evolution of the disease.

(2) Post-traumatic osteoporosis which is left untreated usually results in an ankylosis of one or more of the joints in the region of the porotic bones.

(3) Operations upon the sympathetic nervous system offer a rational and effective surgical treatment for this disease entity.

(4) Cases of post-traumatic osteoporosis treated by sympathectomy during the initial stages of the disease respond quickly and the undesirable sequelæ of the disease are prevented.

(5) Peri-arterial sympathectomy is usually sufficient for cases of post-traumatic osteoporosis which is limited to the distal part of the extremities. Cervical and lumbar sympathetic ramisection should be reserved for the extensive forms of the disease.

REFERENCES

- ¹ Albert F.: Contribution à l'étude clinique et expérimentale des troubles vasomoteurs "réflexes" d'origine traumatique. Thesis, Liège, 1924.
- ² Allison, N., and Brooks, B.: Bone Atrophy; An Experimental and Clinical Study of the Changes in Bone which Result from Nonuse. Surg. Gynec. Obst., vol. xxxiii, p. 250, 1921.
- ³ Babinski, J., and Froment, J.: Hystérie-pithiatisme et troubles nerveux d'ordre réflexe en neurologie de guerre. Masson Editor, Paris, 1917.
- ⁴ Barbé, A.: Raréfaction osseuse dans un cas d'atrophie musculaire progressive spinale à type Duchenne-Aran. C. R. Presse méd., vol. xxvii, p. 35, 1919.
- ⁵ Benkowitz, I.: Über akute Knochenatrophie (Sudeck). Strassburg Med. Zeitung, vol. iii, p. 129, 1906; also Deutsch. med. Wchnschr., vol. xxxii, p. 941, 1906.
- ⁶ Bérard, L., Lumière, A., and Dunet, C.: L'ostéoporose consécutive aux plaies de guerre sans lésions osseuses traumatiques dans un cas de tétanos tardif (fracture pathologique du col du fémur). Bull. méd., Paris, vol. xxxii, p. 3, 1918.
- ⁷ Bibergeil, E.: Traumatische Neurose und Sudecksche Knochenatrophie. Med. Klin., Berlin, vol. vii, p. 921, 1911.
- ⁸ Bienfait, A.: Un cas d'atrophie osseuse de Sudeck. J. de neurol., Paris, vol. xii, p. 149, 1907.
- ⁹ Bonne, C.: Recherches sur les éléments centrifuges des racines postérieures. Thesis, Lyon, 1896-1897.
- ¹⁰ Brandes, Max: Experimentelle Untersuchungen über den zeitlichen Eintritt der durch Inaktivität bedingten Knochenatrophie im Röntgenbilde. München Med. Wchnschr., vol. lx, p. 832, 1913.
- ¹¹ Bressot, E.: Ostéoporoses douloureuses post-traumatiques de Leriche. Bull. et mém. Soc. de Chir. de Paris, vol. xxii, p. 461, 1930.
- ¹² Carrieu, M.: Des lésions osseuses dans les maladies du système nerveux. Gaz. hebd. d. sc. méd., Montpellier, vol. vii, p. 602, 1885.
- ¹³ Cassirer, R.: Die vasomotorisch-trophischen Neurosen. Karger Editor, Berlin, 1912.
- ¹⁴ Cluzet, J.: Examen radiographique et traitement physique des troubles trophiques des extrémités chez les blessés, Lyon Méd., vol. cxxiv, p. 303, 1915.
- ¹⁵ Cohn, M.: Über die Beziehung zwischen Knochenatrophie und Knochenregeneration auf dem Wege der Kalkwanderung. Arch. f. klin. Chir., vol. cxii, p. 231, 1919.
- ¹⁶ Dauriac, M.: Pathogénie des membres ballants et des pseudarthroses. Bull. Acad. Méd., vol. lxxxii, p. 258, 1919.
- ¹⁷ Davidsohn, C.: Über Knochenerweichung im weiteren Sinne, Osteoporose mit Osteomyelitis fibrosa und Periostitis ossificans. Charité Ann., Berlin, vol. xxviii, p. 741, 1904.
- ¹⁸ Delherm, L.: A Propos du diagnostic des raréfactions osseuses. Bull. et mém. Soc. Radiol. Méd. de Paris, vol. iii, p. 88, 1911.
- ¹⁹ Delorme, E.: De la décalcification consécutive aux traumatismes de guerre. Arch. de Méd. et Pharm. Mil., Paris, vol. lxvi, p. 1, 1916-1917.
- ²⁰ Delorme, E.: Sur la décalcification dans les traumatismes de guerre. Bull. Acad. Méd., vol. lxxvii, p. 577, 1917.
- ²¹ Destot, C.: Ostéotrophies traumatiques. Lyon Méd., vol. ciii, p. 236, 1904.
- ²² Doumer, E.: La décalcification du tissu osseux malade. Bull. et mém. Soc. Méd. Chir. du Nord, Lille, vol. i, p. 33, 1905.
- ²³ Dubs, J.: Über Sudecksche Knochenatrophie nach Verbrennungen. München med. Wchnschr., vol. lxviii, p. 1141, 1921.
- ²⁴ Exner, A.: Beiträge zur Kenntnis der akuten Knochenatrophie. Fortschr. a. d. Geb. d. Röntgenstrahlen, vol. vi, p. 1, 1902.

POST-TRAUMATIC OSTEOPOROSIS

- ²⁵ Fontaine, R., and Miloyevitch, D.: Contribution à l'étude expérimentale des troubles vasomoteurs post-traumatiques des membres. *Rev. de Chir.*, vol. xlv, p. 385, 1927.
- ²⁶ Gayet, G., and Bonnet, L. M.: Les altérations osseuses d'origine nerveuse. *Arch. Gén. de Méd.*, Paris, vol. v, p. 495, 1901.
- ²⁷ Grey, E., and Carr, G.: An Experimental Study of the Factors Responsible for Non-infectious Bone Atrophy. *Johns Hopkins Hosp. Bull.*, vol. xxvi, p. 381, 1915.
- ²⁸ Grynfeldt, E.: Sur le processus histologique de l'ostéoporose adipeuse d'origine traumatique. *C. R. Acad. d. Sc.*, Paris, vol. clxxiii, p. 395, 1921.
- ²⁹ Guarini, C.: L'osteoporosi nei traumatizzati di guerra ed in alcuni processi infiammatorii cronici. *Policlino*, Roma, vol. xxv, p. 235, 1918.
- ³⁰ Guéneau, L.: Des données radiographiques dans les ostéotrophies nerveuses. Thesis, Lyon, 1900.
- ³¹ Halipré, A.: Décalcifications osseuses post-traumatiques; évolution des lésions; intérêt de la question dans les accidents du travail. *Rev. Méd. de Normandie*, Rouen, vol. vi, p. 209, 1914.
- ³² Harttung, H.: Über traumatisches Ödem. *Arch. f. klin. Chir.*, vol. cl, p. 288, 1928.
- ³³ Heyman, C. H.: Osteoporosis relieved by sympathectomy. *J. Am. Med. Assn.*, vol. lxxxii, p. 1333 (April 26), 1924.
- ³⁴ Hilgenreiner, H.: Die Knochenatrophie nach Schussfrakturen der Extremitätenknochen und ihre diagnostische, prognostische und funktionelle Bedeutung, *Beitr. z. klin. Chir.*, vol. cxii, p. 473, 1918.
- ³⁵ Hilgenreiner, H.: Gibt es eine Sudeck'sche Knochenatrophie? *Beitr. z. klin. Chir.*, Tübing, vol. cxxix, p. 683, 1923.
- ³⁶ Hitschmann, F., and Wachtel, H.: Die sogenannte Sudeck'sche Knochenatrophie als häufige Folge der Erfrierungen. *Fortschr. a. d. Geb. d. Röntgenstrahlen*, vol. xxvii, p. 621, 1919.
- ³⁷ Hoffa, A.: Zur Pathogenese der arthritischen Muskelatrophien. *Samml. Klin. Vortr.*, vol. xiii, p. 275, 1892.
- ³⁸ Hofmann, H.: Ueber Sudecksche Knochenatrophie. *München med. Wchnschr.*, vol. lxiii, p. 296 (February 22), 1916.
- ³⁹ Imbert, A., and Gagnière, J.: Des atrophies osseuses calcaires consécutives à un traumatisme. *Rev. de Chir.*, Paris, vol. xxiii, p. 689, 1903.
- ⁴⁰ Kienböck, R.: Über akute Knochenatrophie bei Entzündungs-processen an den Extremitäten (fälschlich sogenannte Inaktivitätsatrophie der Knochen) und ihre Diagnose nach dem Röntgen-Bilde. *Wien. Med. Wchnschr.*, vol. li, p. 1345, 1901.
- ⁴¹ Kienböck, R.: Über Knochenveränderungen bei gonorrhöischer Arthritis und akute Knochenatrophie überhaupt. *Wien. Klin. Wchnschr.*, vol. xvi, p. 57, 1903.
- ⁴² Kümmell, H.: Über die traumatischen Erkrankungen der Wirbelsäule. *Deutsch. Med. Wchnschr.*, vol. xxi, p. 180, 1895.
- ⁴³ Lapinsky, M.: Zur Frage über die Beteiligung der Nervenstämmе der hinteren Extremität an der vasomotorischen Innervation der distalen Gebiete derselben. *Virchows Arch. f. Path. Anat.*, vol. clxxxiii, p. 1, 1906.
- ⁴⁴ Legg, A.: The Cause of Atrophy in Joint Disease. *Am. J. Orth. Surg.*, vol. vi, p. 84, 1908.
- ⁴⁵ Leriche, R.: Sur les déséquilibres vaso-moteurs post-traumatiques primitifs des extrémités. *Lyon Chir.*, vol. xx, p. 746 (November-December), 1923.
- ⁴⁶ Leriche, R.: Les réflexes d'axone et les traumatismes périphériques. Importance de leur connaissance et la chirurgie d'accident. *Rev. de Chir.*, vol. xliii, p. 579, 1924.
- ⁴⁷ Leriche, R.: Traitement par la sympathectomie périartérielle des ostéoporoses traumatiques. *Bull. et mém. Soc. Nat. de Chir.*, Paris, vol. lii, p. 247, 1926.
- ⁴⁸ Leriche, R.: Sur quelques maladies osseuses et articulaires d'origine vaso-motrice et sur leur traitement. *Bull. et mém. Soc. Nat. de Chir.*, vol. liii, p. 1022 (July 16), 1927.

- ⁴⁰ Leriche, R.: Indications et résultats de la sympathectomie périartérielle dans la chirurgie des membres. 36^e Congrès Français de Chir., 1927.
- ⁵⁰ Leriche, R.: Mécanisme de production des hydrarthroses et des arthrites traumatiques, conception générale de leur traitement. *Presse Méd.*, vol. xxxvi, p. 769 (June 20), 1928.
- ⁵¹ Leriche, R., and Fontaine, R.: Le rôle des centres vaso-moteurs périphériques en physiologie et en pathologie vasculaires. *Lyon Chir.*, vol. xxvi, p. 323, 1929.
- ⁵² Leriche, R., and Fontaine, R.: Des Ostéoporoses douloureuses post-traumatiques. *Presse Méd.*, vol. xxxviii, p. 617 (May 7), 1930.
- ⁵³ Lewaschew, S.: Experimentelle Untersuchungen über die Bedeutung des Nervensystems bei Gefässerkrankungen. *Arch. f. path. Anat.*, Berlin, vol. xcii, p. 152, 1883.
- ⁵⁴ Lovett, R. W.: The atrophy of muscle and bone resulting from joint-disease, injury and fixation. *J. A. M. A.*, vol. lviii, p. 1576, 1912.
- ⁵⁵ Lusena, G.: Atrofia delle dita (Secrétan) e atrofia delle ossa (Sudeck). *Med. d. Assic. Soc. Infort. d. Lavoro*, Milano, vol. v, p. 33, 1912.
- ⁵⁶ Mairano, M.: Ricerche sperimentali sull'influenza della simpatectomia periarteriosa sul processo di guarigione nelle fratture. *Arch. di Ortop.*, Milano, vol. xli, p. 37, 1925.
- ⁵⁷ Meyer-Hürlimann: Die neuropatische Knochenaffektion in Röntgenbild. *Corr. bl. Schweiz Ärzte*, Basel, vol. xlviii, p. 1031, 1918.
- ⁵⁸ Moreau-Gimelli, E.: De l'atrophie osseuse calcaire traumatique. Thesis, Montpellier, 1912-1913.
- ⁵⁹ Müller, E.: Über einen Fall von akuter Knochenatrophie. *Deutsche Mil. Ärztl. Ztschr.*, Berlin, xlii, p. 387, 1913.
- ⁶⁰ Müller, Walter: Weitere Beobachtungen und Untersuchungen zu der typischen Erkrankung der Sesambeine des I. Metatarsalknochens. *Beitr. klin. Chir.*, vol. cdxv, p. 138, 1926.
- ⁶¹ Nasse, H.: Über den Einfluss der Nervendurchschneidung auf die Ernährung, insbesondere auf die Form und die Zusammensetzung der Knochen. *Arch. f. d. ges. Physiol.*, vol. xxiii, p. 361, 1880-1881.
- ⁶² Nobel, T., and Hauser, E.: Acute Bone Atrophy. *Arch. Surg.*, vol. xii, p. 75 (January), 1926.
- ⁶³ Nonne, Max: Über radiographisch nachweisbare akute und chronische "Knochenatrophie" (Sudeck) bei Nerven-Erkrankungen. *Fortschr. a. d. Geb. d. Röntgenstr.*, vol. v, p. 293, 1902.
- ⁶⁴ Ohlmann, J.: Über die Sudecksche Knochenatrophie. *Fortschr. a. d. Geb. d. Röntgenstr.*, vol. xxiv, p. 517, 1916.
- ⁶⁵ Ollier, L.: *Traité de la régénération des os*. Masson Editor, Paris, 1867.
- ⁶⁶ Ostermann, H.: Zur Differentialdiagnose von Gelenkerkrankungen nach Unfall. *Zentralb. für Chir.*, vol. lvii, p. 2500, 1930.
- ⁶⁷ Pech, L.: Atrophie osseuse calcaire consécutive aux fracas osseux par projectiles de guerre. *Lyon Chir.*, vol. xii, p. 471, 1915.
- ⁶⁸ Pech, L.: L'atrophie osseuse. *Montpellier Med.*, vol. xlii, p. 12, 1920.
- ⁶⁹ Pillet, Emile: Des fractures spontanées succédant à l'immobilisation plâtrée de l'enfant. Thesis, Paris, 1906-1907.
- ⁷⁰ Pradal, A.: Les atrophies osseuses dites "calcaires." Thesis, Montpellier, 1921.
- ⁷¹ Regnault, F.: Les modifications dans la forme et la structure des os d'un membre ankylosé en fluxion provenant de causes biomécaniques. *Bull. et mém. Soc. Anat.*, Paris, vol. lxxxiv, p. 138, 1909.
- ⁷² Robin, A.: La déminéralisation osseuse et son traitement. *Bull. Acad. de Méd.*, Paris, vol. lxxx, p. 241, 1919.

POST-TRAUMATIC OSTEOPOROSIS

- ⁷³ Sans, M. F.: Atrophies osseuses articulaires et abarticulaires consécutives a un traumatisme. Thesis, Lille, 1911-1912.
- ⁷⁴ Schubert, A.: Wachstumsunterschiede und atrophische Vorgänge am Skelettsystem. Deutsche Ztschr. f. Chir., Leipsig, vol. clxi, p. 80, 1921.
- ⁷⁵ Schüller, A.: Über circumscriphte Osteoporose des Schädels. Med. Klin., vol. xxv, p. 631 (April 19), 1929.
- ⁷⁶ Shaffer, N. M.: Selected Essays on Orthopaedic Surgery; with Forewords by Doctor Lovett and Doctor Fisher. G. P. Putnam's Sons, N. Y. & London, 1923.
- ⁷⁷ Shenton, E. W.: Disease in Bone and Its Detection by X-rays. London, Macmillan, 1911.
- ⁷⁸ Stoelzner, W.: Über Knochenerweichung durch Atrophie. Arch. f. Path. Anat., vol. cxli, p. 446, 1895.
- ⁷⁹ Sudeck, P.: Zur Altersatrophie (enschl. Coxa vara senium) und Inaktivitätsatrophie der Knochen. Fortschr. a. d. Geb. d. Röntgenstr., vol. iii, p. 201, 1899-1900.
- ⁸⁰ Sudeck, P.: Über die akute entzündliche Knochenatrophie. Arch. f. klin. Chir., Berlin, vol. lxii, p. 147, 1900.
- ⁸¹ Sudeck, P.: Über die akute (reflektorische) Knochenatrophie nach Entzündungen und Verletzungen an den Extremitäten und ihre klinischen Erscheinungen. Fortschr. a. d. Geb. d. Röntgenstr., vol. v, p. 277, 1901-1902.
- ⁸² Sudeck, P.: Über die akute (trophoneurotische) Knochenatrophie nach Entzündungen und Traumen der Extremitäten. Deutsche Med. Wchnschr., vol. xxviii, p. 336, 1902.
- ⁸³ Tillier, R., and Witas, P.: A propos de la Pathogénie des décalcifications squelettiques. Lyon Chir., vol. xvi, p. 606, 1919.
- ⁸⁴ Turner, H.: Über Nervenschädigungen beim typischen Radiusbruch. Arch. f. klin. Chir., Berlin, vol. cxxviii, p. 422, 1924.
- ⁸⁵ Tyler, A. F.: Bone Pathology as Revealed by the Roentgen-ray, with Suggestions as to Treatment. St. Paul M. J., vol. xvii, p. 647, 1915.
- ⁸⁶ Vialleton, A.: L'ostéoporose localisée a distance dans les lésions traumatiques et inflammatoires des os. Thesis, Montpellier, 1922.
- ⁸⁷ Wertheimer, P.: Contracture physiopathique du membre supérieur. Ramisection. Lyon Chir., vol. xxiv, p. 735, 1927.
- ⁸⁸ Wilde, A.: Akute Knochenatrophie nach Unfall. Med. Klin., Berlin, vol. xi, p. 569, 1915.
- ⁸⁹ Wolff, J.: Über einen Fall von Ellenbogengelenks-Resection. Arch. f. klin. Chir., vol. xx, p. 771, 1877.
- ⁹⁰ Wolff, J.: Über trophische Störungen bei primären Gelenksleiden. Deutsche Med. Wchnschr., Berlin, vol. ix, p. 162, 1883.
- ⁹¹ Ziesche, H.: Zur Lehre von der Knochenatrophie und ihrer Röntgendiagnose nebst Bemerkungen über Knochenatrophie bei chronischer Arthritis. Zeitschr. f. med. Elektrol. und Röntgenk., Leipzig, vol. ix, p. 301, 1907.

IRRADIATION IN CARCINOMA OF THE BREAST

BY IRA I. KAPLAN, M.D.

DIRECTOR DIVISION OF CANCER DEPARTMENT OF HOSPITALS

AND

RIEVA ROSH, M.D.

ASSISTANT RADIATION THERAPIST BELLEVUE HOSPITAL

OF NEW YORK, N. Y.

HOFFMAN places carcinoma of the breast as fifth in the line of cancer death-causing lesions and reports an increase in such cases during the past ten years. The value of irradiation in the treatment of cancer of the breast is still a mooted question; during the past few years there have been adverse reports from qualified clinics, as well as most favorable reports where it is used as a necessary adjunct to surgery or employed alone as the treatment of choice.

Harrington, reporting on breast cancer cases treated at The Mayo Clinic, is of the opinion that irradiation adds nothing of value to the surgical treatment of cancer of the breast. On the other hand, Smith and Bartlett, of Boston, in their study of malignant tumors of the breast, state there is a distinct benefit following pre-operative and post-operative irradiation. In 1929, Pfahler and Widmann, from a study of a great many cases treated in Philadelphia, conclude that X-ray therapy is of value in all cases of cancer of the breast. More recently, Pfahler and Parry in reviewing more than 900 cases from their private practice conclude, because of the theoretical, experimental and clinical proof of its value, that irradiation is advisable and state that from their experience over a period of twenty-five years they have found pre-operative and post-operative irradiation of distinct benefit. In thirty-nine cases of operable carcinoma of the breast treated by irradiation alone they had a five-year cure factor of 85 per cent. Levine, who had a large number of advanced cancer cases to deal with in the New York City Cancer Institute, definitely states that irradiation is a necessity in treating these conditions and that often non-operable cases were made operable by irradiation. Lee, in 1928, reports a definite value in the use of irradiation in the treatment of cancer of the breast. He describes the results of treatment in cases where it was used either pre- and post-operatively by radiation alone or with palliative surgery, and expresses his belief that in inoperable cases irradiation ameliorates the condition and prolongs life. Ward states that much can be done with irradiation in inoperable cases to relieve suffering while controlling the progress of disease.

Certain it is that in cases of metastatic involvement irradiation is of real value. Lenz and Fried found it of great ameliorative worth in a large number of cases such as are found in a home for incurable cancer cases like the

Montefiore Hospital. In the case of six male patients treated at Bellevue Hospital and reported by Rosh, we believe that irradiation definitely hindered the malignant growth and prolonged the life of the patients. Trout and Peterson are of the opinion that the results in the treatment of breast cancer cases are markedly improved with irradiation following radical surgery, and they report that a recent questionnaire showed 89 per cent. of the surgeons in accord with this opinion. Similarly, Bevan, who has had a great deal of experience in breast cancer work, favors post-operative irradiation as a necessary means of treating carcinoma of the breast.

If the success of surgical procedures and the operability of breast cases depends on how early the involved breast is recognized, then in estimating the value of such statistics, these factors must also be likewise considered in a résumé of results from radiated cases.

In a free hospital or clinic such as Bellevue, where patients are rarely received in an early stage, and most often in an advanced condition of the disease, patients cannot be chosen according to their economic status or the extent of their disease as is the case in those institutions whose only surgical methods of treatment are considered of value and as to which favorable statistics are reported. In these latter institutions, most of the cases naturally are of the early-stage type, as they must be if they are to be considered operable. In a large general municipal hospital, however, where the patients are drawn from a plane of life in which the economic struggle for existence is very severe, those applying to the clinic for relief usually do so when their normal daily duties are interfered with and when the local lesion which presents itself has appeared late in the course of the general disease and thus it is seldom that a tumor of the breast is noted in an early stage. Usually it is the result of advanced involvement that calls attention to the offending lesion and forces the patient to apply for relief despite her economic status, which prevented her coming to the hospital when the condition first began. This economic factor has important bearing on the type of tumor growth seen and any statistical data must therefore take cognizance of it. In such cases it is that we must look for a more rapid extension from the original growth and in which irradiation, which tends to limit this advancement of the disease, is of real value.

As the extent and duration of the tumor affect the operability and the post-operative prognosis, so too they must affect the curative power of radiation therapy. We have regarded the presence of supraclavicular metastases as contraindicating radical mastectomy and the presence of pulmonary and skeletal metastases as precluding the possibility of any surgical procedure, except in cases of ulcerated foul breasts when a simple mastectomy may be done. Stubenbord reports that in the 108 cases at the New York Hospital during a period of fifteen years most of them had lymphatic gland involvement.

Not all breast cancer cases coming to Bellevue Hospital are referred for irradiation, but during the period 1924-1930, radiation therapy was requested

in 270 cases. Due to the low economic status of such patients it has not been possible to keep in touch with 123 of them after treatment was administered, and so while for purposes of record we have herewith reported those cases adversely, some may still be alive, although our records show patients alive only up to their last visit to our clinic. The frequent change of domicile customary among the poor makes it quite impossible to insure any record otherwise in most of these cases. Up to the present time X-ray therapy in carcinoma of the breast was deemed of most value after operation. Now, however, many therapists believe pre-operative irradiation of more value and, based on our experience for the past two years, we are of the opinion that pre-operative irradiation is of exceptional value in all cases. This assumption is based on the direct action of the irradiation on the malignant cells which are either killed outright or hindered in their growth. For it has been shown time and again that growing malignant cells are most vulnerable to intensive irradiation. Irradiation also stimulates the defensive processes of normal tissues which thereby inhibit extension and further growth of the malignant cells. It likewise definitely limits tumor growth to the tissue already involved, so that its removal may be safely accomplished. Lee definitely states that healing is not retarded by pre-operative irradiation.

On the third surgical service at Bellevue Hospital, we have pre-operatively irradiated all operable breast cases since 1929; there were twelve such cases and no difficulty has been experienced in healing in any of them.

Of the 270 cases referred to the Bellevue Radiation Department for treatment during the period 1924-1930, 264 were females and six males. Of these, 215 were referred for post-operative irradiation, twelve for pre-operative and post-operative irradiation, forty for irradiation alone and three for irradiation and operation. As shown by Lee and Tannenbaum, inflammatory cancer cases do very badly with surgical therapy and we, too, have found it better to treat such cases only with palliative radiation. Two cases were treated with endothermic removal of the involved breast and then irradiated.

In our series most cases appeared in married women and especially in those who had had children. This is in accord with the findings of Stubenbord, but is contrary to the report of Summers who states that lactation hinders carcinoma growth and that in Pennsylvania most cases occurred in single women. There were 228 married and thirty-six single women, and six married men. Of the married women 157 had had one or more children; 142 had nursed their children and 113 had no children. In two cases pregnancy followed radical removal of one breast with post-operative X-ray therapy. Of the total number 255 were white and fifteen were colored patients; fifty-two were Jews.

In our series it appears that there was little difference in the predilection of the cancer site, for the right and the left breast were nearly equally involved. In 139 cases the right breast was involved, in 121 the left, and in ten cases both breasts.

As to the age when the patients reported for treatment, most of them

IRRADIATION IN BREAST CANCER

were between the ages of thirty to forty-five years, somewhat earlier than Stubenbord's patients. The number of cases grouped according to years, was as follows:

| | | | | | | |
|-------|-------|-------|-------|-------|-------|-------|
| 20-30 | 31-40 | 41-45 | 46-50 | 51-60 | 61-70 | 71-80 |
| 9 | 50 | 48 | 40 | 66 | 49 | 8 |

Only thirty-seven gave a history of trauma to the breast, yet but eight reported to the clinic with the duration of symptoms of less than one month. The others had symptoms varying from one month to more than five years before reporting to us for aid. They are grouped as follows:

| Months | | | Years | | | |
|--------|-----|------|-------|-----|-----|--------|
| 0-1 | 1-6 | 6-12 | 1-2 | 2-3 | 3-5 | 5 plus |
| 8 | 72 | 68 | 55 | 32 | 17 | 18 |

With regard to the extent of the lesion, in no case was the condition limited to the breast, all cases having extension beyond the local lesion. This secondary involvement affected either the local or adjacent lymphatics or the skeletal and visceral structures. The secondary involvements occurred most frequently in the lymph nodes of the axilla on the same side as the lesion; in ten cases both axillas were affected. In thirty-five cases the supraclavicular glands of one side were involved and in seven both supraclavicular spaces. The secondary involvements were as follows:

Two hundred cases involvement of one axilla; ten cases involvement of both axillas; thirty-five cases involvement of one supraclavicular area; seven cases involvement of both supraclavicular areas; eighteen cases involvement of opposite breast; twenty-three cases involvement of the skin; nineteen cases involvement of the pleura; eleven cases involvement of the lungs.

The number of cases with skeletal metastases were not so numerous as those reported by Lenz and Fried; there were but thirty-seven cases so involved. In twenty-two cases most of the skeleton was involved, including the skull, in nine cases the spine alone was involved, the pelvis in four and the sternum and hips in one case respectively. The viscera were involved in seven cases, six in the liver and one the stomach. Three cases of brain metastases occurred; two were proven by autopsy and one of them was reported by Schweitzer in 1931. From the pathological standpoint there were: three cases of Paget's; one case of giant-cell sarcoma; fourteen cases of scirrhous carcinoma; 252 cases were carcinoma of the adeno or duct-cell type.

The time in which treatment was carried out was as follows:

| | | | | | | |
|------|------|------|------|------|------|------|
| 1924 | 1925 | 1926 | 1927 | 1928 | 1929 | 1930 |
| 38 | 22 | 28 | 49 | 36 | 51 | 47 |

Results of treatment showed sixty-two of all the cases alive and well at the present time. In calculating the period of time alive following treatment the time was figured up to the last report to the clinic. In as much as many of these patients fail to come back to the clinic on account of economic conditions, no doubt some of the patients are alive beyond the time shown

in our schedule. There are eighty-five known dead. The length of life after treatment of the known living cases is as follows:

| Year | Cases Treated | <i>Known to be alive after treatment</i> | | | | | | | |
|------|------------------|--|--------|--------|--------|--------|--------|-------|----------------|
| | | 7 yrs. | 6 yrs. | 5 yrs. | 4 yrs. | 3 yrs. | 2 yrs. | 1 yr. | Less than 1 yr |
| 1924 | 38 | 4 | 1 | 3 | 2 | 1 | 6 | 7 | 14 |
| 1925 | 22 | | 1 | 1 | 1 | | 4 | 2 | 13 |
| 1926 | 28 | | | | 6 | 2 | 5 | 4 | 11 |
| 1927 | 49 | | | | 9 | 6 | 4 | 18 | 12 |
| 1928 | 36 | | | | | 9 | 4 | 9 | 14 |
| 1929 | 51 | | | | | | 18 | 13 | 20 |
| 1930 | 47 | | | | | | | 38 | 9 |

From our records we are inclined to believe with Lee that the clinical index of malignancy is of more value than the histological findings in our cases. The older patients live much longer following treatment.

Of the twelve pre-operatively irradiated cases ten are alive, and it is our opinion this method of procedure is of real value in operable cases and that operation is not made more difficult or hazardous.

Treatment with radium and X-rays alone was used in thirty-nine cases. One case treated by irradiation alone was subsequently operated upon.

The employment of irradiation alone as the treatment for cancer of the breast has as yet been the procedure in only a few instances. Keynes, of London, believes that if cases to be so treated are chosen with the same criteria as breast-operable from the surgical standpoint, radiation will give equally good results. Lee suggests that irradiation be given first choice in selected operable cases, and, when properly carried out according to the method in use at Memorial Hospital, will give good results. A method in use at the New York City Cancer Institute was reported by Cutler in 1931. The reason to treat a breast lesion by irradiation was not its operability from the standpoint of the local tumor growth but because of the general physical involvements in the patient, such as severe cardiac, pulmonary or associated lesions. In some of our cases age was the factor which barred surgical procedure. From the cases treated it is our considered opinion that such irradiation therapy is of value in selected cases.

The technic which we believe will give the best results is a combination of external irradiation over the local area involved and the adjacent lymphatic drainage tissues, together with interstitial treatment with properly designed and filtered radium needles or tubes, as described by Kaplan in 1931, by Adair in 1930, and recently also by Lee and Pack. As in all surgical procedures, the technic employed must be scientifically carried out by those trained in such work; mediocre attempts at irradiation are equally as harmful as mediocre surgery.

Summary.—A report is made of 270 breast cases treated by the Radiation Therapy Department during the period of 1924–1930.

In our service post-operative irradiation is deemed of value.

IRRADIATION IN BREAST CANCER

Pre-operative irradiation, in our experience, is of distinct value in prolonging the life of the patients and preventing recurrences.

Radiation therapy alone has proven of value for inoperable cases and in several chosen operable ones.

Judgment in choosing cases and proper technic in treatment are essential for attaining good results.

BIBLIOGRAPHY

- ¹ Adair, F. E.: Radiological Review, March, 1930.
- ² Bevan, A. D.: Jour. Am. Med. Assn., vol. xcv, No. 18, p. 1311, 1930.
- ³ Harrington, S. W.: Jour. Am. Med. Assn., vol. xcii, No. 3, p. 208, 1929.
- ⁴ Hoffman, F. L.: The Cancer Record of 1930. The Specktor Company, New York City, June 18, 1930.
- ⁵ Kaplan, Ira I.: Am. Jour. Roentgenol. and Rad. Ther., vol. xxv, No. 2, 1931.
- ⁶ Keynes, G.: Lancet, p. 439, February, 1930.
- ⁷ Keynes, G.: Acta Radiologica, No. 10, p. 393, October, 1929.
- ⁸ Lee, B. J.: ANNALS OF SURGERY, vol. lxxxviii, p. 26, July, 1928.
- ⁹ Lee, B. J., and Tannenbaum, N. E.: Surg., Gynec. and Obstet., vol. xxxix, pp. 580-595, November, 1924.
- ¹⁰ Lee, B. J., and Stubenbord, J. G.: Surg., Gynec. and Obstet., vol. xlvii, p. 812, December, 1928.
- ¹¹ Lee, B. J., and Herendeen, R. E.: Radiology, vol. ii, p. 121, March, 1924.
- ¹² Lenz, M., and Freid, J. R.: ANNALS OF SURGERY, vol. xciii, January, 1931.
- ¹³ Levine, I.: Arch. Clin. Cancer Res., vol. 1, No. 4, 1925.
- ¹⁴ Pfahler, G. E., and Widmann, B. P.: Am. Jour. Roentgenol. and Rad. Ther., vol. xxi, No. 6, p. 546, 1929.
- ¹⁵ Pfahler, G. E., and Parry, L. D.: Jour. Am. Med. Assn., vol. xciv, No. 2, 1930.
- ¹⁶ Pfahler, G. E., and Parry, L. D.: ANNALS OF SURGERY, vol. xciii, June, 1931.
- ¹⁷ Rosh, R.: Am. Jour. Surg., New Series, No. 3, vol. xiii, p. 514, 1931.
- ¹⁸ Schweitzer, E.: Med. Jour. and Rec., p. 239, March 4, 1931.
- ¹⁹ Stubenbord, J. G.: Surg., Gynec. and Obstet., vol. lii, No. 5, p. 1001, 1931.
- ²⁰ Summers, J. E.: Surg., Gynec. and Obstet., vol. liii, p. 566, October, 1931.
- ²¹ Trout, H. H., and Peterson, C. H.: Jour. Am. Med. Assn., vol. xcv, No. 18, p. 1307, November, 1930.
- ²² Ward, R.: Brit. Med. Jour., Abst. Jour. Am. Med. Assn., vol. xcii, No. 15, p. 1307, 1929.

SARCOMA OF THE STOMACH

By J. LOUIS RANSOHOFF, M.D.

AND

THOMAS R. DICKSON, M.D.

OF CINCINNATI, OHIO

THE object of this communication is to place on record two cases of sarcoma of the stomach. Sarcoma is a comparatively unusual form of neoplasm arising from the gastric wall. Ewing estimates that sarcomata constitutes 1 per cent. of all stomach tumors. In his review of cases in 1920, Haggard found that 244 cases had been reported, of which 107 came to operation, the diagnosis in the remainder having been made by post-mortem. In 1930, D'Aunoy and Zoller were able to collect 335 cases. They agree that sarcomata form 1 per cent. of all cases of stomach tumor. Oschner and Smithies, in their analysis of 921 cases of stomach tumor, found four sarcomata. Anschutz and Konjetzny believe that sarcoma of the stomach is more frequent and constitutes about 2 per cent. of all gastric neoplasms.

The pathology of these cases is extremely interesting. From a gross pathological viewpoint, they may be divided into three classes: first, the intra-gastric; second, the extra-gastric; and third, a gross sarcomatous infiltration, resembling linitis plastica.

Schlessinger agrees to the classification of extra-gastric, submucosal and mucosal or infiltrating. The extra-gastric, according to all observers, occurs most frequently. The pylorus is not, as in carcinoma, the seat of predilection, so that obstruction is a rare symptom. However, Schlessinger had a case of this kind. According to Kauffmann, the extra-gastric and submucosal varieties are of long duration and not of high-grade malignancy. Metastases occur in about one-third of the cases untreated by operation, and are most frequently found in the abdominal lymph-glands, although the liver and the more distant organs may be involved. Of seventy cases collected by Bertrand, there were four intra-gastric, thirty-two infiltrating and thirty-one extra-gastric. The intra-gastric, originating in the submucosa, spread under and lift the mucosa, involving a varying area of the stomach. They may become pedunculated as in Case I. After they have been present for a certain length of time, an ulceration of the mucosa may develop, resulting in necrosis and hæmorrhage. Ewing believes that these cases are really myosarcoma and originate in a sarcomatous change in a fibromyoma of the stomach, very much in the same manner in which sarcomata may result from uterine fibroids. This, however, has not been borne out by many other authors, as the microscopical appearance in most of these cases is a typical fibro- or spindle-cell sarcoma. This form may be comparatively non-malignant and may run a long course.

SARCOMA OF THE STOMACH

The infiltrating sarcomata are also usually of the round-celled variety and involve a large part of the stomach, frequently resulting in a condition resembling linitis plastica. In these cases a microscopical section is necessary to differentiate them from carcinoma. The extra-gastric variety, which are either fibrosarcoma or spindle-cell sarcoma, are the most interesting of the group. They originate in the subserous connective-tissue layer and spread from the stomach, frequently involving so little of the stomach wall that they become pedunculated, the involved area of the stomach forming the pedicle. They may reach a large size. A case reported by Deaudinsky weighed six kilos. In form, they are usually spherical or nodular, and frequently show hæmorrhagic areas and cystic degeneration. These tumors arise either from the greater curvature or the posterior surface of the stomach, and spread between the layers of the gastrohepatic or gastrocolic omentum. It is extremely difficult to make the diagnosis in this type of case, and they are often mistaken for Banti's disease, tumor of the kidney or mesenteric cysts. One of the most striking features of these extra-gastric sarcomata is that on first opening the abdomen they appear completely inoperable, because of their omental covering and their adhesions, but after careful dissecting, a large number of these tumors can be successfully removed. This is particularly true, as, unlike carcinoma, the line of demarkation between the tumor and the normal stomach is well defined and sharply outlined. As the cases are comparatively benign, there is a large percentage of recoveries.

Lymphosarcoma of the stomach may occur as metastasis in any form of lymphoblastoma, secondary to a primary lesion elsewhere. Ewing has described them in Hodgkin's disease, the various leukemias, melanotic sarcoma and in generalized lymphosarcoma. These cases, of course, have no surgical significance.

Symptoms.—The most instructive single series of cases are the fifty-four which were studied at The Mayo Clinic in twenty years. In these a positive microscopical diagnosis was made in forty-five and a gross pathological diagnosis in the remaining nine. The average age of the Mayo cases was forty years, the youngest ten years and the oldest sixty-seven years. In most of the collected series of cases the greatest prevalence is in the fifth decade.

The duration of the disease before the advice of a surgeon is sought is frequently of long standing, usually over a year. Pain was present in nineteen cases, dyspepsia in twenty-three, bleeding in sixteen, and tumor in twenty-six. The tumor was situated in the mid-epigastric line in thirteen, to the left of the epigastrium in eleven, and to the right of the epigastrium in two cases. Bleeding is frequent, and may take the form of either hæmatemesis or melæna. These hæmorrhages are at times massive, and recur during the entire course of the disease. A palpable tumor is present in over half the cases, and in the extra-gastric variety may take any location, and may be mistaken for other diseases. For instance, in two of Mayo's cases and one to be reported below, the diagnosis of Banti's disease was made. This diagnosis, of course, is favored by the secondary anæmia, due to repeated gastric hæmorrhages. This is particularly confusing as gastric hæmorrhage is a frequent early symptom of Banti's disease.

A case somewhat of this nature was reported by Schiff.¹⁰ The patient was admitted to the General Hospital with an acute illness. He had chills and fever. A large tumor

mass was discovered occupying the site of an enlarged spleen. In spite of the X-ray diagnosis of gastric ulcer, the diagnosis of splenic abscess was made. At operation a sarcoma of the posterior surface of the stomach was discovered, which had ulcerated into the lesser peritoneal cavity, forming a large abscess. Microscopical diagnosis of leiomyosarcoma was made.

Of the fifty-four cases reported from The Mayo Clinic, the clinical diagnosis of carcinoma was made in thirty, abdominal tumor in eight, ulcer in five, benign tumor of the stomach in three, Banti's disease in two, and sarcoma of the stomach in two. With the increasing interest in these cases it is possible that a correct diagnosis may be more frequently made. The treatment is, of course, surgical, as no other form of therapy seems to be of benefit.

Of the fifty-four cases reported from the Rochester Clinic, thirty-eight were operable, a very much larger percentage than is found in cases of carcinoma of the stomach which come to operation. Of those cases operated, there were twelve cures for from one to nine years.

Freeman reported a very interesting case of inoperable lymphosarcoma. The diagnosis was proven by operation, and the patient subjected to X-ray treatment and was alive two years after exploration. This is, of course, possible only in cases of lymphosarcoma, as they are most amenable to X-ray therapy, owing to their embryonal structure and their consequent radio-sensitivity. The fibrosarcoma are resistant to X-ray, and very little can be accomplished from X-ray therapy.

Unlike carcinoma, large resections are not so important, as the tumor is sharply demarkated from the normal stomach. If the tumor can be removed with a generous portion of the stomach, leaving sufficient stomach remaining to close in continuity, a typical gastric resection is not only unnecessary, but needlessly dangerous. The mortality of those cases operated on at the Mayos' was 13 per cent., slightly lower than that of operations for carcinoma of the stomach. The records of the two cases recently under our observation are as follow.

CASE I.—Mrs. C. B. P., aged forty-two years, was admitted to the Jewish Hospital, August 10, 1930, complaining of abdominal distress. She states that she has not been in good health for four years, and has suffered from abdominal pain and indigestion. During this period she has had four gastric hæmorrhages, and has frequently noticed blood in the stool. Her left breast was amputated thirteen years ago at the Good Samaritan Hospital. *Microscopical Diagnosis.*—Fibrocarcinoma. Two years ago, an X-ray examination was made with the resulting diagnosis of duodenal ulcer. She has had numerous courses of Sippey treatment. She is weak, short of breath and very pale. Her blood-pressure is 140/88, the pulse slow. The abdominal examination shows a rigidity and slight tenderness in the upper left quadrant. A mass is felt under the left rib, which moves with respiration. The size of this mass is impossible to estimate.

A skiagraph (Fig. 1) showed a large circumscribed filling defect in the middle of the stomach, due to a tumor which arises from its anterior wall.

August 12, 1930, a transfusion of 500 cubic centimetres whole blood was given. August 13, 1930, the abdomen was opened through an upper mid-line incision, and a fairly large tumor mass was discovered, springing from the anterior wall of the stomach and projecting into its lumen. The tumor was almost pedunculated. It was removed with a generous portion of the surrounding stomach wall. The stomach was closed in layers, and the abdominal wall closed by wire sutures. There were no post-operative complications. The pathological microscopical diagnosis was fibrosarcoma.

Before discharge September 6, 1930, an X-ray examination revealed a stomach

SARCOMA OF THE STOMACH

which showed slight deformity in its mid-section. A blood examination revealed erythrocytes, 3,610,000. Hæmoglobin, 40 per cent.

CASE II.—F. P. C., male, aged sixty-one years, was admitted to the Jewish Hospital, November 7, 1931. In August of this year the patient had an attack of pain which was diagnosticated as pleurisy, and responded to rest and medical treatment. At that time X-ray examination revealed an infection of the left ethmoidal sinus, for which a drainage operation was performed. Gastro-intestinal symptoms had never been present. October 20, 1931, he suddenly became weak, nauseated and vomited about eight ounces of blood. The rest of the history is essentially negative.

Abdominal examination shows the liver palpable two fingers-breadth below the right costal margin. A mass can be palpated which extends up under the costal arch and seems to take the position of an enlarged spleen. The tumor is freely movable. As nearly as can be estimated the size is that of a child's head. The blood examination is given in detail, as it shows why the diagnosis of Banti's disease was made.

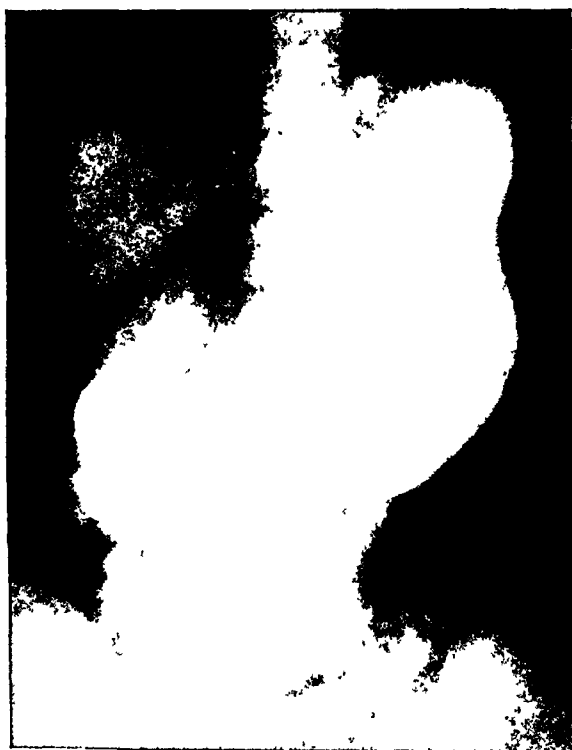


FIG. 1.—Case I.



FIG. 2.—Case II.

Hæmoglobin, 45 per cent. (Sahli); white cells, 8,600; red cells, 3,020,000; reticulocytes, 40,000; platelets, 224,000; clotting time, 2.5 minutes; bleeding time, 4.5 minutes; clot retraction, normal.

A skiagraph (Fig. 2) showed the stomach displaced to the right and forward by a large circular mass in the region of the left hypochondrium. The posterior wall of the stomach is deformed apparently due to adhesions between it and the tumor. Though the tumor occupies the region of the spleen it was not thought to be due to splenic enlargement, because the mass was circular instead of being oval, as is the case with splenic enlargement. Furthermore, the mass was adherent to the stomach, which does not occur with enlargement of the spleen. It was therefore concluded that the tumor was either a pancreatic tumor or a retroperitoneal tumor, but not a spleen.

The combination of enlarged spleen, hæmorrhage from the stomach, slight enlargement of the liver and the blood-picture, led to a diagnosis of Banti's disease in spite of the X-ray report.

A transfusion of 500 cubic centimetres of whole blood was given November 16, 1931, and the patient operated upon November 17, 1931. Under ethylene anæsthesia, a mid-line

incision was made. On opening the abdomen, a large tumor mass could be seen, covered by the greater omentum. The omental vessels were enormously dilated. An incision was made through the omentum and the tumor still found covered by the gastrohepatic omentum. This was separated and the surface of the tumor exposed. It was found to be nodular and apparently of sarcomatous nature. Frozen section at this time showed spindle-cell sarcoma. As the extraneous blood supply was controlled and the tumor itself was not particularly vascular, an attempt was made to remove it. After further tying the large vessels of the omentum, the tumor was separated by manual manipulation from the diaphragm, to which it was adherent by tenuous avascular adhesions. After this separation the entire tumor was dislodged from its bed. As it was dislodged the normal spleen was seen to detach itself from the lower pole of the tumor and drop back into the abdomen. In its development the tumor had taken the place of the spleen, dislodging the spleen before it. The spleen fitted on the lower end of the tumor, much as the suprarenal fits on the upper pole of the kidney. After the tumor was delivered, it



FIG. 3.—Extra-gastric sarcoma showing cystic degeneration.

was seen to spring from the posterior wall of the stomach. The differentiation between the stomach wall and the tumor was clearly marked. The tumor with the involved portion of the stomach wall was resected and the stomach closed. The patient was shocked following operation, and an immediate transfusion of 500 cubic centimetres of whole blood was given.

The growth was an irregular lobulated tumor mass, twenty by thirty by fourteen centimetres, weighing 1,280 grams. A portion of the omentum was attached to the mass. A small portion of the stomach formed a part of the mass. There is an ulceration of the stomach. A large part of the tumor has undergone hæmorrhagic cystic degeneration. (Fig. 3.) *Microscopical Diagnosis*.—Spindle-cell sarcoma. After a stormy convalescence, which was complicated by a pneumonia of the left lower lobe, the patient made a complete recovery.

CONCLUSIONS.—(1) Sarcoma constitutes between 1 and 2 per cent. of all gastric tumors.

(2) They present a higher percentage of operability than carcinoma of the stomach.

SARCOMA OF THE STOMACH

(3) As the tumor is usually sharply demarkated from the normal stomach, a resection of the tumor can frequently be made and the stomach sutured in continuity. Needlessly dangerous radical resections can thus be avoided.

BIBLIOGRAPHY

- ¹ Douglas: *ANNALS OF SURGERY*, vol. lxxi, 1920.
- ² Haggard: Quoted by Balfour, *Surg., Gynec., and Obst.*, vol. xxxi, p. 505, 1920.
- ³ D'Aunoy, and Zoller: *Amer. Jour. of Surg., New Series*, vol. ix, 1930.
- ⁴ Anschutz, and Konjetzny: *Die Geschwulste des Magens-Stuttgart*, 1921.
- ⁵ Schlessinger, H.: 1916; *Wien. klin. Wchnschr.*, vol. xxv, 1916.
- ⁶ Kauffmann: *Pathology*, vol. i, p. 692, 1929.
- ⁷ Crohn: *Diseases of the Stomach*, 1928.
- ⁸ Ewing: *Neoplastic Diseases*, p. 277, 1928.
- ⁹ Balfour, D. C.: *Surg., Gynec., and Obst.*, p. 948, June, 1930.
- ¹⁰ Schiff, Leon, and Foulger, Margaret: *Jour. Am. Med. Assn.*, vol. xcvi, p. 942, March 21, 1931.

PARTIAL HYSTERECTOMY AND THE USE OF THE STUMP OF THE UTERUS TO SUPPORT THE BLADDER IN THE VAGINAL OPERATION FOR PROLAPSE

By G. PAUL LAROCQUE, M.D.

OF RICHMOND, VIRGINIA

FROM THE DEPARTMENT OF SURGERY, OF THE MEDICAL COLLEGE OF VIRGINIA

THE many operations which have been advised for prolapse of the uterus and bladder may be classified into two major groups: (1) Those performed from above through the abdomen, (2) those performed from below through the vagina. In many cases, operation through both routes of approach is called for. Decision as to which route to employ will be influenced largely by the extent of the cystocele. A moderate protrusion of the bladder may be corrected by suspension of the uterus from the abdominal side as a supplementary procedure after repair of the perineum. In those cases in which the cure of the cystocele is the major problem, the desired purpose is usually best accomplished by an operation through the vagina.

The several commonly employed operations designed for this purpose are intended to give support to the bladder, by interposition of the uterus or broad ligament into the area located between the bladder and the vault of the vagina.

That the operation should be made to fit the patient rather than the patient made to fit the operation is obviously indisputable. The use of a rational procedure which, with material at hand, can be fitted successfully to a great majority if not all cases is highly desirable.

For the cure of cystocele, it is quite indisputable that the best results will be secured by employing for support of the prolapsed bladder an adequate amount of uterus or the broad ligaments pulled down from their position within the peritoneal cavity and sutured firmly into a new position beneath the bladder to whatever fascia may be present in the vault of the vagina.

As a matter of fact, the problems of plastic surgery are not wholly unlike those of altering clothes until a proper fit is secured. The operation for cystocele is largely a job of ladies' tailoring, not so much for looks as for the relief of distressing symptoms.

The use of the entire uterus, according to the method usually designated as the Watkins operation, finds wide acceptance, and is satisfactory in many cases.

There are, however, certain cases in which the uterus is so large that after interposition according to the Watkins method there will be found a bulging tumor at the site of the former cystocele, which is unsatisfactory even to a widow, and may come down broadside into the vagina.

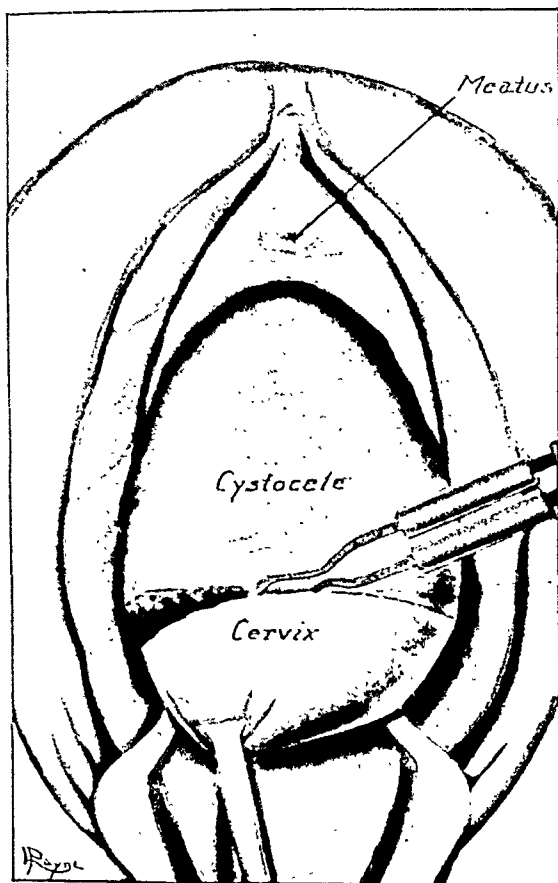


FIG. 1.—Cervix pulled down and being amputated with cautery knife.

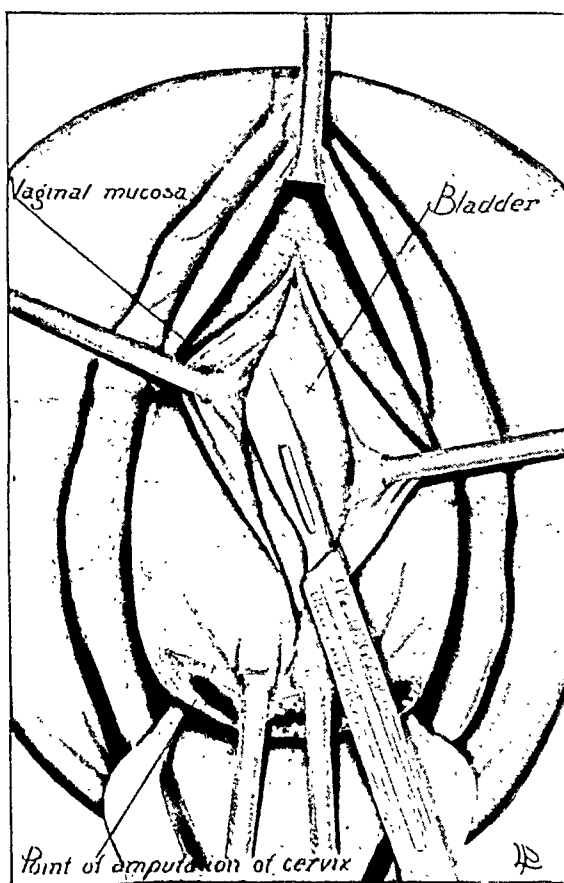


FIG. 2.—The vaginal mucosa being dissected off, exposing the bladder.



FIG. 3.—Bladder being brushed up and dissected until the peritoneum comes into view.

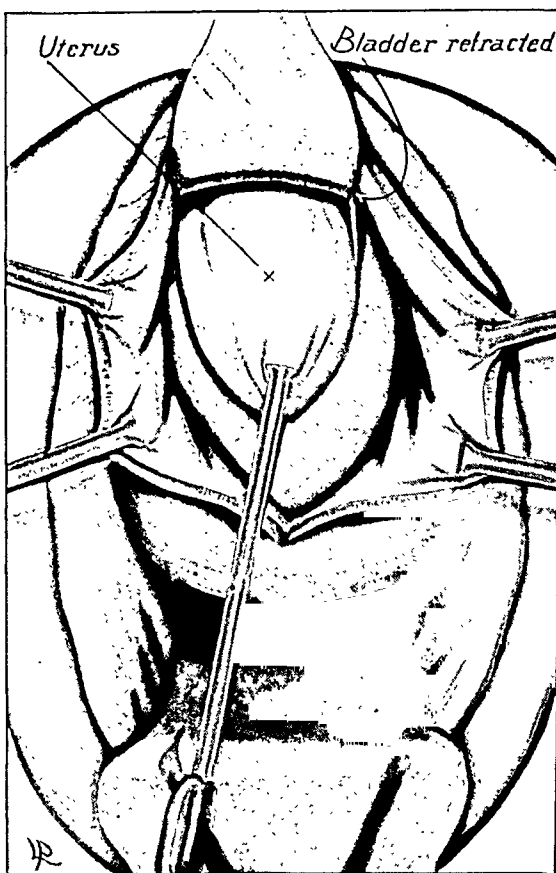


FIG. 4.—The peritoneum has been opened, the fundus of the uterus pulled out of the peritoneal cavity.

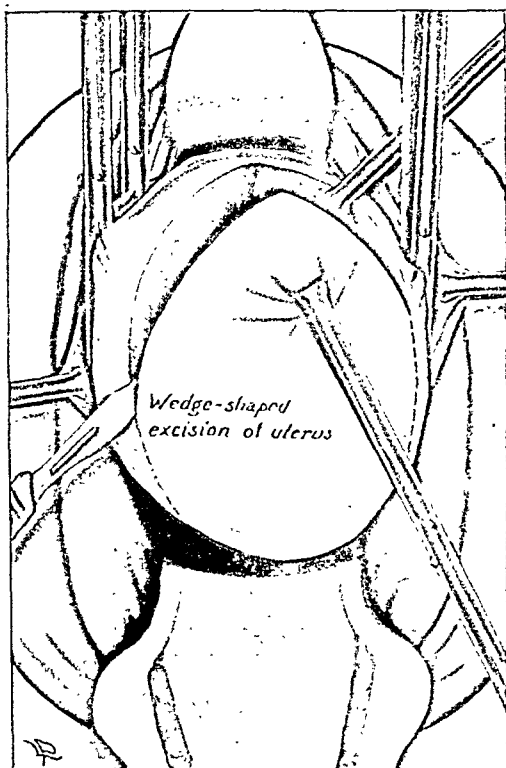


FIG. 5.—A large wedge-shaped piece of the uterus being excised, including the whole fundus, down to the internal os.

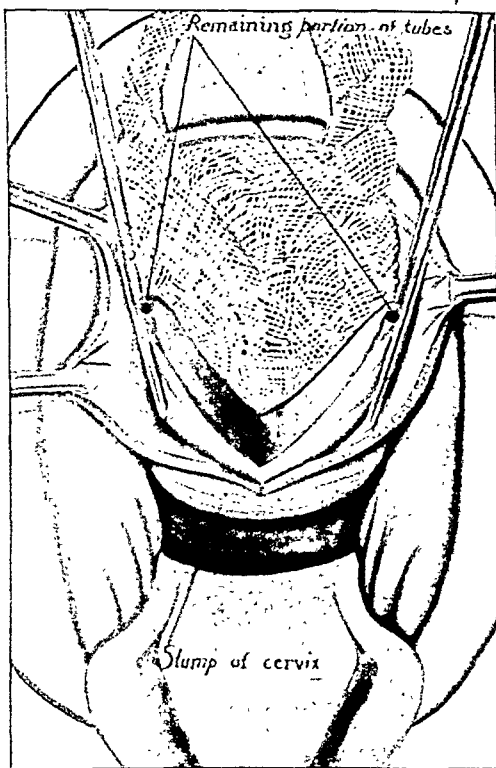


FIG. 6.—A small piece of the lateral walls of the uterus left after excision of the fundus.

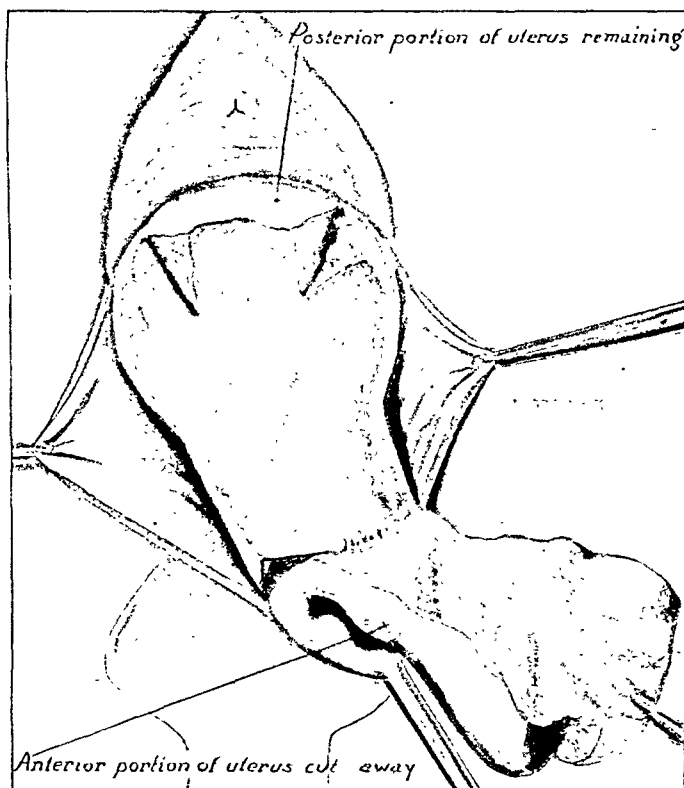


FIG. 7.—The whole anterior wall of the uterus, including the cervix and the interstitial part of the tube, is excised according to the method of Masson. This picture is redrawn from Masson's article in Minnesota Medicine, February, 1929.



FIG. 8.

FIG. 8.—The sides of the uterus and ligaments sutured together after excision of the wedge shaped portion of the fundus. In this case the uterine ends of the tubes are allowed to remain, and the division of the tubes between ligatures is shown.

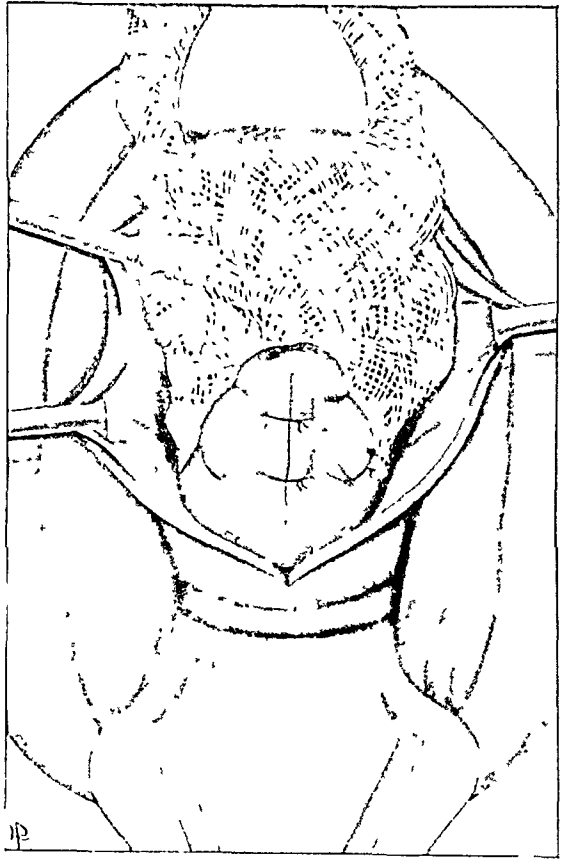


FIG. 9.

FIG. 9.—A small stump of the cervix sutured together after removal of nearly all the uterus.

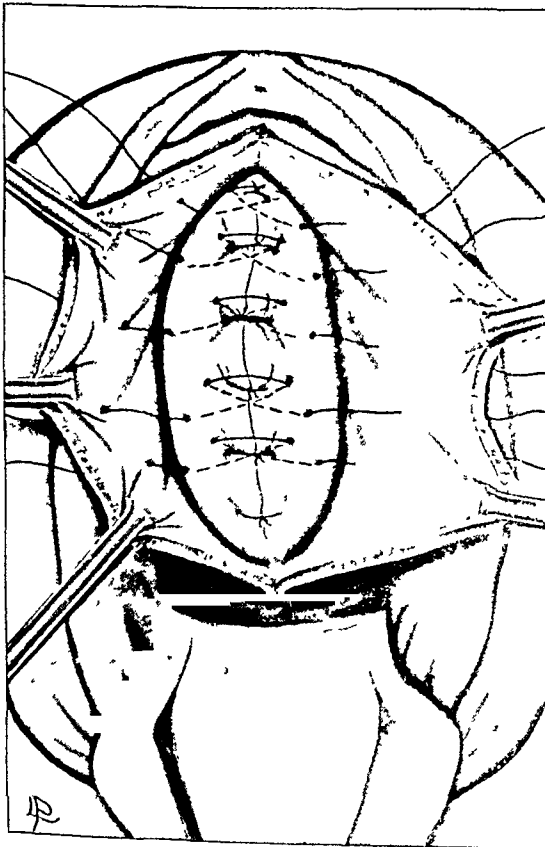


FIG. 10.

FIG. 10.—The stump of the uterus interposed under the bladder is being sutured to the vaginal mucosa. Note the figure-eight hæmostatic sutures in the uterus.

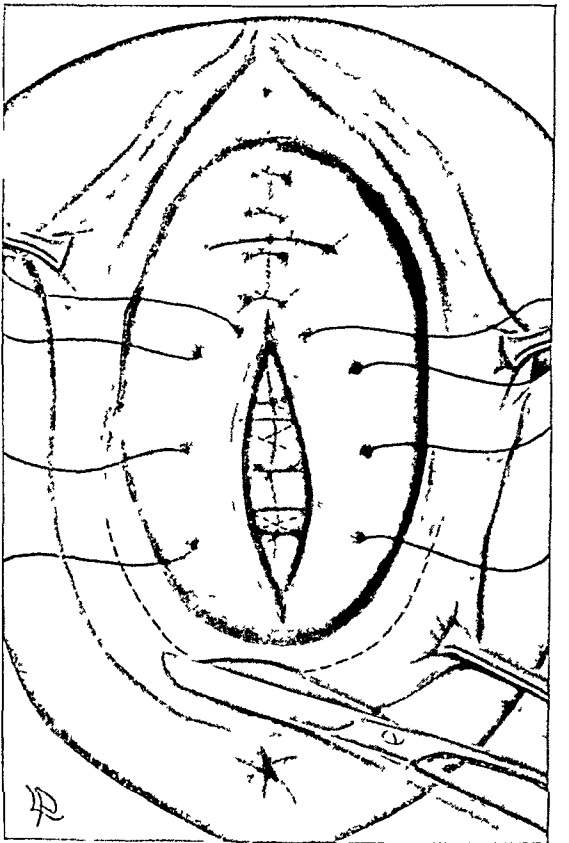


FIG. 11.

FIG. 11.—Edges of the vaginal mucosa being sutured, and perineorrhaphy being started.

For extensive prolapse in old women with small uterus and long ligaments, the removal of the cervix and the overlapping of the broad ligaments serve to give support, as is shown by the extreme popularity of the Mayo operation. To remove the cervix, however, always entails a certain risk, such as accidental opening of the rectum and injury to the ureters, and though these dangers and hæmorrhage may be avoided by painstaking care on the part of skillful surgeons, accidents will occasionally happen, especially in the hands of less skillful operators.

Moreover, there are cases in which, after removal of the uterus, the broad ligaments, if sutured together, according to the method of Mayo, will be found to be under considerable tension and liable to pull apart, permitting recurrence of a much larger cystocele. For this situation, with the cervix

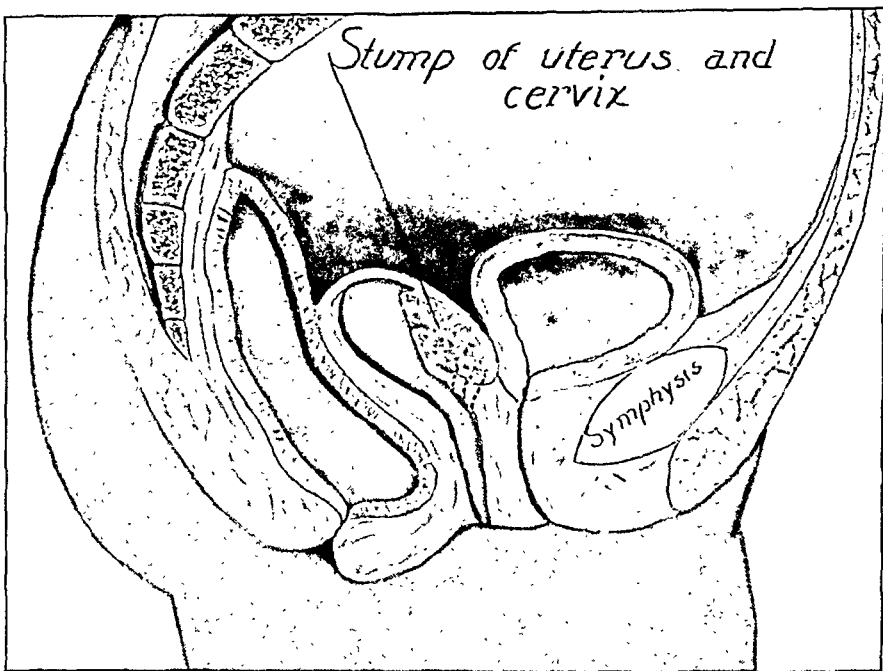


FIG. 12.—Diagram of the sagittal section showing position of the bladder and the stump of the uterus at the completion of the operation.

and its supports gone, the recurrent cystocele, if curable at all, may call for the ingenious and tedious abdominal operation devised by Robert Payne.³

About a year ago, when about to operate upon a case of extensive cystocele and uterine prolapse in a fat woman fifty-one years old, it was found that to have sutured the entire uterus in place by the Watkins method would have left an undesirable tumor in this location; and to have removed the uterus would have been unwise because of the fact that the broad ligaments might have been too short to have permitted their suture according to the proper Mayo procedure.

To solve the problem, after delivering the fundus of the uterus in the usual manner, it was seen that the uterus could be reduced very considerably in size by excising a wedge-shaped piece, involving the whole fundus, and about half the width of the body of the uterus down to the level of the

internal os. This was done. The sides of the remaining piece of uterus sewn together made a nice fit and left a sufficient amount of tissue to bring up into position underneath the bladder, and made a very satisfactory foundation upon which the bladder could rest, leaving no bulge in the vault of the vulva.

I have performed this operation in women ranging in age from thirty-six to sixty-five years, and in varying degrees of prolapse. The appearance at the conclusion of the operation and nearly a year later is so satisfactory that I venture to report the procedure as a useful one for the cure of nearly if not all cases of cystocele.

I have not found the procedure described. It is mentioned by H. J. Boldt in discussing Mayo's operation before the Southern Surgical Association, in 1914.¹ I have learned through correspondence with J. C. Masson that he has removed the anterior portion of the uterus, including the cervix, in selected cases.²

It is comforting to know that the idea has been tested by good surgeons. The operative procedure is as follows:

The cervix is pulled down in the usual way, and amputated nearly up to the internal os with an electric cautery knife. (Fig. 1.)

With a tenaculum holding the cervix steady, the vaginal mucosa is divided from a point three-fourths inch behind the meatus, almost to the point of cautery amputation. The vaginal mucosa is dissected off around to the side, giving good exposure of the bladder. (Fig. 2.)

The bladder is pushed up by a gauze-covered finger and with the aid of scissors, and pushed upward until the peritoneum comes into view. (Fig. 3.)

The peritoneum is divided in the usual way and the fundus caught either with the finger or tenaculum, and pulled into the vagina as traction is released from the cervix. (Fig. 4.)

A large or small piece of the uterus is excised, including the fundus, and all the endometrium, leaving only enough uterine wall to bring together by suture, and place under the bladder for support. (Figs. 5 and 6.)

The edges of the uterus are held in neat apposition with mattress sutures. (Figs. 8 and 9.)

The stump of the small piece of remaining uterus is now interposed between the bladder and the vagina. For this purpose the figure-eight stitch for placing sutures in the uterus, as suggested by Cullen, prevents bleeding and subsequent accumulation of blood in the space after operation. (Fig. 10.)

Finally, the edges of the incision in the vagina are brought together by interrupted sutures. Perineorrhaphy is then performed. (Figs. 11 and 12.)

BIBLIOGRAPHY

¹ Transactions Southern Surgical Association, 1914.

² Masson: Minnesota Medicine, February, 1929.

³ Payne: Archives of Surgery, April, 1930.

PILONIDAL SINUS

BY MANDEL WEINSTEIN, M.D.

OF LONG ISLAND CITY, NEW YORK

IN REVIEWING the subject of pilonidal sinus (sacro-coccygeal; dermoid; pilonidal cyst) the reader wonders at the lack of scientific consideration accorded a condition not infrequent in hospital practice. In 1867, J. M. Warren,¹³ who was the first to record this lesion, remarked that nowhere had he seen mention made of it. He noted the tendency to confusion with fistula-in-ano, and advised complete removal. However, in 1880, Hodges⁸ offered the name "pilonidal cyst"—from "pilus" meaning hair, and "nidus" meaning nest.

The lesion can be described, in its uncomplicated form, as a small opening in the skin, three or four millimetres in diameter, at the level of the sacro-coccygeal joint, and usually in or near the posterior mid-line of the body.¹² The orifice is round or oval, edges smooth, covered by skin, and free from granulation tissue. Occasionally, one will notice a small tuft of hair projecting through the opening. A probe¹⁰ passed into the sinus tract is directed upward, a method of differentiation from fistula-in-ano, the sinus of which points toward the anal ring.

If pyogenic infection is present, physical examination discloses a red swelling, with or without fluctuation, and a sinus usually above the anus, rarely a little to one side. Below the swelling and between it and the anus may be observed one or more post-anal or coccygeal dimples always in the mid-line.⁹ The cysts may suppurate and be mistaken at first for ischio-rectal abscesses or fistulæ, the true nature of the condition being discovered only at operation.

Pathology.—Histologically, the tract is lined with epithelium. Often a small switch of hair is found lying loose in the sinus.⁶ Unless suppuration has destroyed the walls of the sinus, the tract is lined by skin. The sinus ends blindly in a sacculated pouch, and does not communicate with any other structure.

The surface is lined by stratified squamous epithelium with deep ingrowths, papillary in shape, but well confined by a basement membrane. The supporting tissue is widely infiltrated by inflammatory cells, polymorpho-nuclear, lymphocytic and monocytic. Focal necrotic areas containing giant phagocytic cells with ingested débris are scattered through the section.

The dermis includes typical glandular structures and hair follicles. Some of the sweat glands lie in the fat at a distance from the lumen of the sinus. In short, the sinus is a modified invagination of true skin, none of its elements being fully developed. Even the characteristic hair is thin, fine, and scanty in pigment.

PILONIDAL SINUS

Etiology.—The condition, although congenital,³ first gives trouble in early adult life. Of the thirteen cases herewith reported, the average age incidence was twenty-five years—the youngest being seventeen years old, and the oldest thirty-nine years. Eleven, or 85 per cent., were males, and two, or 15 per cent., females. Hyzer W. Jones stresses trauma as an etiological factor. However, this was noticeably lacking in the present study. No cases of pilonidal sinus were ever noticed in the Negro race. Lawson Tait regarded the dimples as defects due to the evolutionary disappearance of a caudal

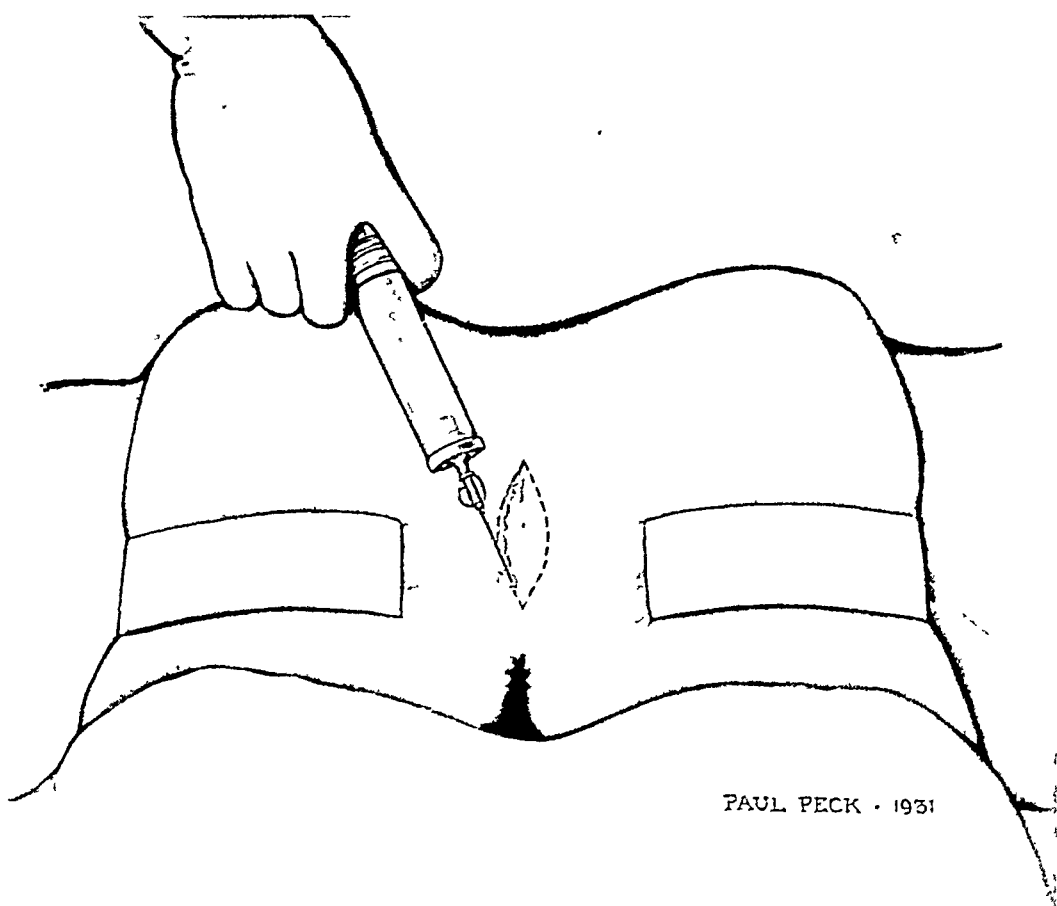


FIG. 1.—Elliptical infiltration of sinus area, including scars of previous operations. Adhesive strips aid the exposure.

appendage. The most plausible modern embryological theory regards pilonidal sinus as a special local downgrowth of epithelium, originating from the true skin, and not the medullary groove.

Treatment.—A number of these patients have had previous operations, the operation consisting of incision and drainage for suppuration along the pilonidal sinus. The greatest number of incisions according to Hayter⁷ was eighteen.

Brams⁴ injected lipiodol, and Crookall⁵ silver nitrate, endeavoring to obliterate the sinus by non-operative measures. Morter¹¹ emphasizes the use

of Carrel-Dakin solution post-operatively in order to prevent recurrence, but its value is questionable.

The following is a method for radical excision of the sinus which is simple to perform, and thus far has obviated recurrences.

Operation.—The patient lies face downward on the table, with a pillow under the pelvis to elevate the buttocks. Obliteration of the natal cleft and flattening out of this region is accomplished by adhesive plaster,² thus eliminating an assistant. Strips three inches wide spread the buttocks apart when attached to the inside of each buttock and fastened just anterior to the anterior superior spine of the ilium. Picric acid 5 per cent. in alcohol is used to prepare the skin. At the same time the solution is generously applied to the adhesive strips, thus sterilizing the entire field of operation.

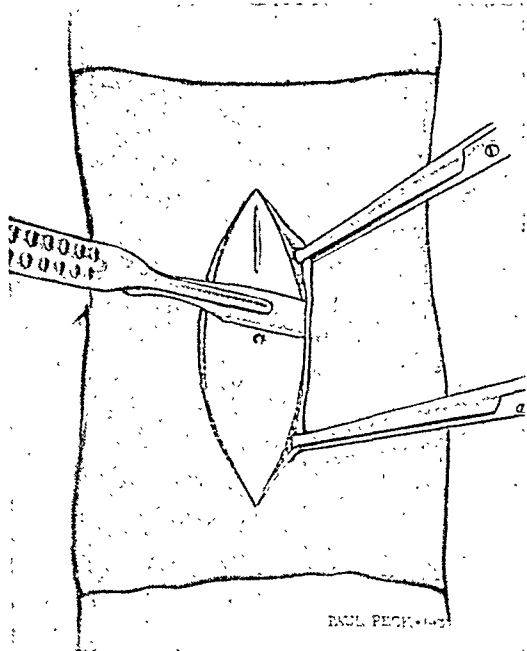


FIG. 2.

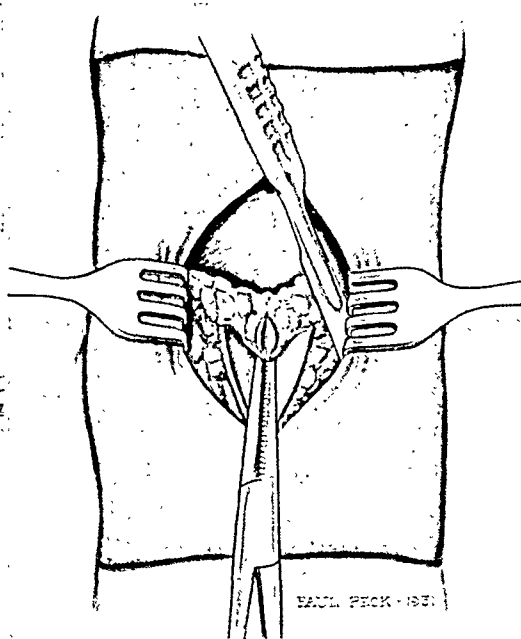


FIG. 3.

FIG. 2.—After incising the skin, the scalpel undermines the tissues for three-quarters of an inch.
FIG. 3.—The scalpel continues to incise in an oblique direction, and strips the tissue *en masse* from the sacrum and coccyx.

Local infiltration anæsthesia, 1 per cent. novocaine with adrenalin chloride, induces anæsthesia. The ischæmic field produced permits easy recognition of the outermost regions of the lesion. Injection of the sinus with methylene blue is ineffective, inasmuch as not all the ramifications of the lesion are penetrated by the fluid. An elliptical incision is carried well beyond the sinus opening and all scars of previous operations, extending through the skin and into the subcutaneous adipose tissue.

The scalpel is then tilted at an angle to undermine skin and a thin layer of fat, for a distance of one-half to three-quarters of an inch. Further dissection is maintained in an oblique plane so that the base of the excised tissue is much larger than the superficial skin-covered portion. In the deep

PILONIDAL SINUS

aspect of the wound, the dissected mass is stripped from the periosteum of the sacrum and coccyx in the mid-line, and on the sides from the gluteal fascia covering the gluteal muscles. In fact, the sinus tissue was so adherent to the periosteum of the sacro-coccygeal region in several cases that only by excising periosteum itself could complete removal of sinus wall be assured. Thorough, wide excision, easily visualized with firm retraction and careful sponging of the wound, is the only safeguard against recurrence. Not more than one or two bleeding vessels require ligation. Four or five tension sutures of the Stewart type coapt the skin, and grasp a portion of underlying subcutaneous tissue. Lack of skin sutures, as suggested by Babcock, prevents early healing and leaves a painful cicatrized mass at the bottom of the spine.¹ A small cigarette drain is placed in the lower-most angle. No

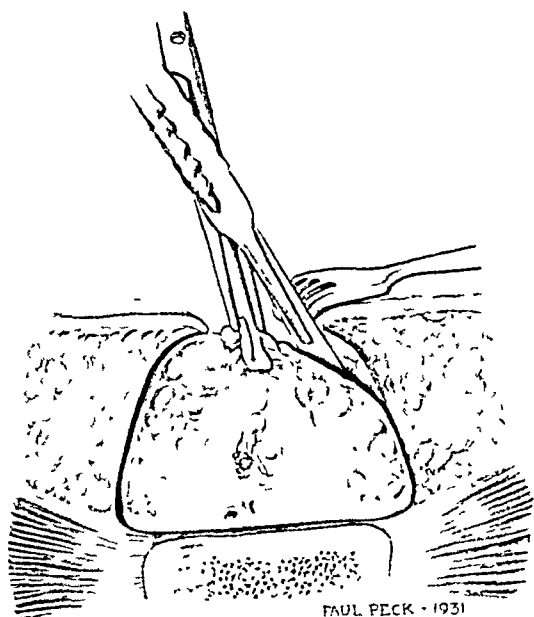


FIG. 4.

FIG. 4.—Cross-section showing contour of excised tissue, and section through lesion. Note tuft of hair and fibrous strands which are in close relationship with sacrum and coccyx.

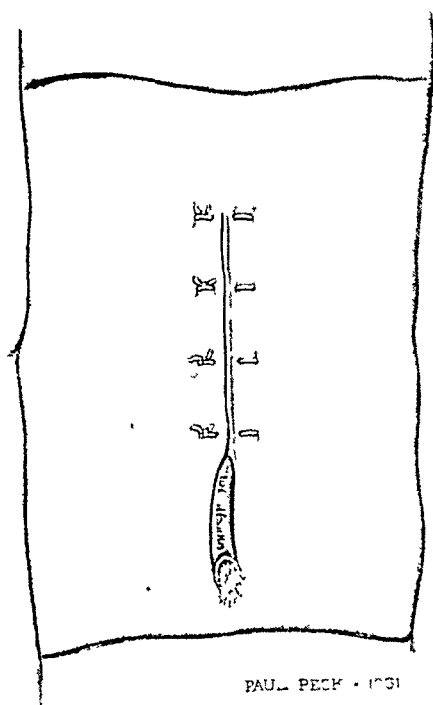


FIG. 5.

FIG. 5.—Wound edges coapted with interrupted sutures. Calibrated drain through lower angle.

attempt is made to approximate subcutaneous tissue, gluteal fascia or muscles, as individual layers.

CONCLUSIONS.—(1) Pilonidal sinus is more common than one would suppose from a survey of the literature. The conclusions and suggestions for permanent removal as evolved in this study are based on thirteen cases operated upon by the author.

(2) The differentiation of pilonidal sinus from fistula-in-ano is readily made by the absence of granulation tissue, and the upward direction upon probing.

(3) Pilonidal sinus is a special local downgrowth of epithelium, originating from the true skin.

(4) A large section of tissue with a broad base and narrower superficial skin surface will help to prevent recurrence. If necessary, periosteum of sacrum and coccyx, and gluteal fascia are removed when involved.

(5) No attempt should be made to completely eliminate dead space—this is impossible.

BIBLIOGRAPHY

- ¹ Babcock: Text Book of Surgery, p. 468, W. B. Saunders Company, 1928.
- ² Bease, C.: New England Journ. Med., vol. cciii, p. 729, October 9, 1930.
- ³ Bevan, A. D.: Surgical Clinics of Chicago, vol. iii, No. 3, p. 753.
- ⁴ Brams, J.: Radiology, vol. viii, pp. 248-249, March, 1927.
- ⁵ Crookall, A.: Transactions Amer. Proct. Society, 1927, vol. xxviii, pp. 32-40, May 13, 1928.
- ⁶ Graham: Surgical Diagnosis, vol. iii, p. 603, W. B. Saunders Co., 1930.
- ⁷ Hayter, Harry M.: Virginia Med. Monthly, vol. liv, No. 1, pp. 447-448, April, 1927.
- ⁸ Hodges: Boston Med. and Surgical Journal, p. 45, 1880.
- ⁹ Jones, Hyzer W.: N. Y. State Journ. Med., vol. xxvii, pp. 845-846, August 1, 1927.
- ¹⁰ Keen, Wm.: Text on Surgery, vol. ii, pp. 831-832, W. B. Saunders Co., 1912.
- ¹¹ Morter, C. W.: Trans. Amer. Proct. Society, pp. 13-17.
- ¹² Stone, Harvey B.: ANNALS OF SURGERY, vol. lxxix, pp. 410-414, March, 1924.
- ¹³ Warren, J. M.: Surgical Observations, p. 192, Boston, 1867.

SYPHILITIC LEG ULCERS

CLINICAL FEATURES PRESENTED BY 100 CASES

BY REGINALD A. CUTTING, M.D.

OF NEW ORLEANS, LA.

FROM THE DEPARTMENT OF SURGERY OF TULANE UNIVERSITY AND THE CHARITY HOSPITAL

THE clinical material upon which this study is based consists of 100 clinical cases seen by the author in a colored male surgical clinic of the Charity Hospital of New Orleans between September 15, 1930, and July 1, 1931. The clinic is a general surgical clinic and serves patients from five years of age upward.

The basis on which the ulcers were diagnosed as luetic was purely clinical, and lest this statement be considered to discount the subsequent discussion and conclusions in the estimation of the reader, an attempt should be made to justify the basis of selection before proceeding farther. It might be argued that leg ulcers cannot, or should not, be diagnosed as syphilitic unless the patient can be shown to present a definitely positive serological reaction for syphilis. It is partly this idea, partly an error in logic which leads White¹ to what I believe an unwarranted conclusion. Arguing from the premises (1) that syphilis is said to be from three to eight times more common in men than in women and (2) that ulcers of the leg are four times more frequent in the female than in the male, White concludes that "syphilis is not the strong determining influence it is supposed to be" in the production of leg ulcers. This rather prevalent idea also leads Eloesser² to the conclusion that "true gummas of the legs are rare in comparison to the frequency of ordinary leg ulcers," for he finds that in a series of seventy-six leg ulcers of various types seen at the San Francisco Hospital, the Wassermann reaction was positive in only eleven cases.

Naturally, the percentage incidence of syphilis varies greatly in different parts of the country and in different social strata in any given part of the country, and, for that reason, the relative number of cases of any manifestation of syphilis seen in any given community or by any given individual may be small or great depending upon his geographical location and the class of patients he treats. In the particular clinic from which these cases were taken, the serological incidence of the disease is unusually high, as shown in a previous communication,³ at least 35.5 per cent. Accordingly, if one were to use the Wassermann reaction or any other serological reaction for syphilis as the most important consideration in differential diagnosis in this particular clinic, the conclusion would be inevitable that more than one-third of all lesions, not only ulcers of the leg, but bone felons and bunions, are syphilitic. In other words, it should be clearly appreciated that the fact that a patient is syphilitic as shown by a serological reaction is by no means an infallible indi-

cation that any given lesion from which he may be suffering is syphilitic, whether that lesion be an ulcer of the stomach or an ulcer of the leg.

To return to the principal line of thought, had I collected the present series of cases on the basis of serological reaction rather than clinical manifestations, I should have laid myself liable to the mistake of including on the one hand certain ulcers, arteriosclerotic, mycotic, varicose or otherwise, which happened more or less fortuitously to occur in syphilitic patients, and of excluding, on the other hand, certain ulcers which presented all the clinical manifestations of a syphilitic lesion, except the serological reaction. As a matter of fact, I am convinced as a result of a rather extensive experience with syphilitic patients in a large charity hospital that in this locality at least, of all syphilitic lesions, the leg ulcer is perhaps less likely than any other to be associated with a positive serological reaction. A history of previous genital ulceration of several weeks' duration, previous antisyphilitic treatment in a reputable institution, or a childless marriage of several years' duration is, I am fully convinced, of much greater diagnostic significance. This is probably due in part to the fact that the syphilitic leg ulcer is an extremely late manifestation of the disease and that the age period at which it characteristically occurs is relatively far advanced—facts which will soon be substantiated by statistical evidence.

The value of underlying osseous and especially periosteal changes in the diagnosis of luetic ulcers of the leg is a debatable question. I had originally intended to cause to be taken and to examine skiagrams of the legs of all the cases in the present series with the idea of establishing the diagnostic value of the association between luetic periostitis and luetic ulcer. I had not proceeded very far, however, before it became apparent, on the one hand, that many ulcers both clinically and serologically luetic showed no such osseous and periosteal changes, whereas, on the other hand, the changes under discussion were very apparent in connection with many ulcers which had existed for long periods of time and which were very obviously not syphilitic.

Certainly clinical evidences of tibial periostitis do not occur in all cases of lues. In a recent careful survey* of 304 cases from the same clinic from which this study is taken, there were seen only twenty-two cases of clinical tibial periostitis.

Skiagrams are much more reliable for the purpose of showing bone changes than clinical methods, but Stokes⁴ states that the outright X-ray diagnosis of syphilis is possible in only forty-eight per cent. of cases and I am sure that such a figure is not too conservative. More will be said about the osseous changes associated with leg ulcers subsequently, but the consideration of interest at present is that the diagnosis of syphilitic ulcer of the leg cannot be made or refuted solely on the basis of associated osseous and periosteal changes. Because I became thoroughly convinced of this fact before the investigation had proceeded more than halfway, I did not consider the expense involved in a complete study of routine skiagrams to be warranted, and ac-

* Unpublished.

cordingly, I am unable to report a complete series of correlations between the X-ray appearance of the underlying bones and the occurrence of syphilitic ulceration of the overlying soft parts.

Perhaps the present study could have been made more valuable had the procedure of biopsy been adopted routinely. In favorable cases, it is undoubtedly possible to diagnose luetic lesions on the basis of tissue architecture. The technical difficulties involved in such a procedure in any considerable series of cases, such as the present one, are so great, however, that, although the procedure was contemplated, the idea was rather promptly abandoned. In any case, it is questionable whether biopsy would have been diagnostic in a really large percentage of cases, considering the duration of most of the lesions and the concomitant tissue changes introduced by secondary infection. At all events, to my knowledge this procedure never has been adopted on a sufficiently large scale to furnish data on which a satisfactory comparison with such a series as the present one could be based.

Accordingly, the diagnosis of syphilitic ulceration of the lower extremity in the last analysis and in the present stage of development of diagnosis is a matter of clinical manifestations rather than laboratory data. These data are of great value as confirmatory evidence in doubtful cases, but cannot be considered as disproving the diagnosis when they do not confirm it. As a matter of fact, the diagnosis of the particular lesion under discussion is not at all difficult when it is understood that it represents a disintegrated cutaneous or subcutaneous gumma, which becomes an open lesion by a process of necrosis and ulceration. The history of the mode of development of the lesion, together with the appearance of the typical cavity after the ulcerating gumma has become detached, showing as it does its circular or ovoid contour and perpendicular walls, is sufficiently diagnostic in most cases to render the etiology of the lesion relatively certain. Of course, in any case a final conclusion cannot be reached without carefully considering the differential diagnosis, and every effort was made in assembling the present series of cases to avoid including ulcers associated with varicose veins or with marked arterial vascular changes or any ulcers in which the appearance of the lesions suggested that mycotic infection or malignant changes might be present.

Before dismissing this introductory part of the discussion, an especial point should be made of what I consider to be a very valuable, perhaps the most valuable, sign in the differential diagnosis of luetic ulcers, regardless of their location—I refer to the characteristic odor of these lesions. Certainly this odor previously has not received the attention to which it is entitled. Indeed, the only unmistakable references to it which I can find in the literature are those by Brocman,⁵ who states that from the ulcer “a yellow serosanguinous fluid exudes, which has an almost unbearable odor,” and by Ochsner and Garside,⁶ whose attention was directed to the odor by experience in the same clinic from which the present series of cases was collected. Dr. I. M. Gage first called my attention to the peculiar stench of these lesions, and my subsequent experience leads me very firmly to the belief that it is not

only invariably present in the early stages of the luetic ulcer wherever situated but that it is a peculiar odor not associated with any other lesion. I have often attempted to frame some sort of description of the odor in words, but the result has been far from satisfactory. The odor is exceedingly foul, so much so that it can often be detected as a patient enters the room and before the lesion has been exposed—a veritable stench which may or may not be strong but is exceedingly pervasive; it presents some of the characteristics, especially the sourness, of the foulest of old cheese, but it is nauseating like the odor of moist gangrene. I am willing to hazard a guess that the odor results from certain volatile fatty acids derived from the disintegration of the subcutaneous fat of the patient. I have been especially observant of this odor in the assembly of the present series of cases.

Pathology.—The syphilitic leg ulcer represents a broken-down cutaneous or subcutaneous gumma, very rarely a gumma of periosteum or even bone. The gumma, of course, is a typical granuloma and shows the characteristic histopathological picture of such lesions. It consists of granulation tissue, shows perivascular infiltrations of lymphocytes and plasma cells, and usually contains a few giant cells. The regional blood-vessels show hyperplastic or obliterative endarteritis, and because of these vascular changes, the gumma, sometimes early, but especially in its later stages, shows mucoid degeneration and central caseation necrosis. The gumma proper is surrounded by fibro-connective tissue in which there are usually to be seen imperfect new blood-vessels.

Microscopically, an early gummatous lesion is a solid, either firm or soft, generally rounded mass which, on cross-section, is yellowish or grayish in color. When interference with its blood supply occurs, it rapidly undergoes central caseation necrosis, and when incised or when it ulcerates spontaneously, it discharges a characteristic thick, yellowish, usually sterile, necrotic material. Frequently the contents of the lesion are not completely necrotic at the time of evacuation, and in such cases, a softened core of yellow tissue remains behind for a few days, but its attachments soon become liquefied and the mass then usually comes away *en masse*, leaving a clean-cut cavity lined by a thickened membrane or cortex, the surface of which tends to be regularly rounded and smooth. The ulcer or cavity left by the lesion may be shallow, but is frequently deep, the floor in the latter case sometimes consisting of the external surface of the subjacent muscular plane. In such cases, the floor is frequently as clean as if a careful artificial dissection of the muscles had been performed.

Clinically, a cutaneous or subcutaneous gumma is a painless lesion unless it has undergone secondary infection with the ordinary pyogenic bacteria, in which case it can only with difficulty be differentiated from those abscesses representing infected hematomas. In the case of gumma with secondary infection, the differential diagnosis from infected hematoma is especially difficult because in most cases both lesions present a history of previous trauma.

Cutaneous and subcutaneous gummas may occur on any part of the body.

SYPHILITIC LEG ULCERS

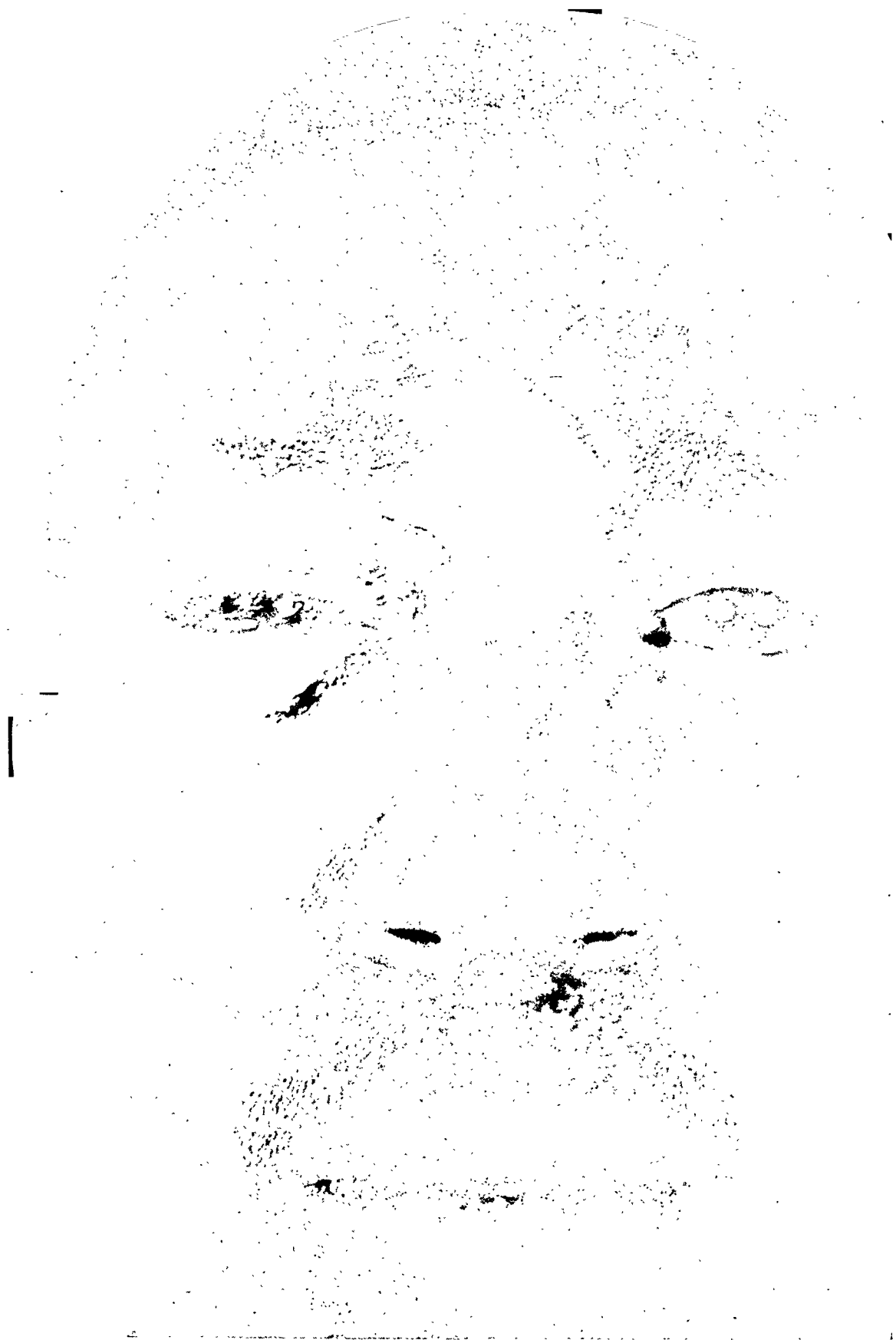


FIG. 1.—L. S., aged twenty-four years. Cutaneous gumma inner cantus right eye. Duration—two weeks. Wassermann—strongly positive. Ulcer healed under active antiluetic therapy in four weeks.

I have seen them on the face, neck, breast, abdomen, arms, hands, legs and feet. The accompanying photograph of such a lesion near the inner canthus of the eye is an example of a rare location. (Fig. 1.) Incidentally, it so happens that I have under observation and treatment at the present time three cases in which the lesion occurred on the same portion of the upper extremity: *viz.*, just above the left elbow on the inner surface of the arm. Two of these lesions I have been able to observe throughout virtually their entire development. I first saw them as small, firm, non-tender nodules freely movable beneath the skin. They gradually increased in size, the skin over the surface of each gradually became somewhat reddened, but still not acutely tender or painful, and they ultimately broke through the skin. The



FIG. 2.



FIG. 3.

FIG. 2.—H. S., aged thirty-six years. Subcutaneous gumma left arm, inner aspect, just above elbow. Began as slightly painful swelling four days ago: progressive enlargement under home treatment to "bring it to a head." Penile ulcer, presumably chancre, two years ago. Wassermann—strongly positive. Note necrotic gumma still *in situ* and compare with Fig. 3.

FIG. 3.—Same patient as Fig. 2, two days later. Attachments of gumma have become liquefied and entire gumma has been lifted out with forceps. Base consists of superficial surface of muscular plane. Lesion healed completely in three weeks under antiluetic therapy.

accompanying photographs show two stages in the development of one of these lesions after ulceration had occurred. In the first (Fig. 2) the gumma is still *in situ*, attached loosely to the base of the ulcer, soft, yellow and friable. The latter photograph (Fig. 3) was taken *three* days later and shows how cleanly the necrotic gumma came away, leaving the underlying muscles completely exposed.

As a rule, cutaneous gummata heal rather rapidly under the influence of anti-syphilitic treatment. When actively treated, it is distinctly unusual for the lesion to remain open for more than two or three weeks, the time interval depending in large part upon the extent of the lesion, particularly the surface

SYPHILITIC LEG ULCERS

area destroyed. The arsenobenzols and mercury sometimes serve to effect a cure in the absence of iodide medication, although the iodides are, of course, indicated in most cases, and I have seen these lesions heal on what is colloquially known as "mixed treatment"; *viz.*, a prescription for oral administration containing mercury in the form of bichloride and iodine in the form of potassium iodide—a form of treatment which, to say the least, is not very efficacious.

Peculiarly, cutaneous gummas, when they occur below the knee and break down to form luetic ulcers, frequently do not behave like similar lesions elsewhere but show a remarkable tendency to become chronic. Not all such ulcers behave thus, for not infrequently patients under treatment for chronic syphilitic leg ulcers give a history of the occurrence of previous similar lesions situated either at the same site or in an adjacent locality which apparently presented the same type of onset and clinical characteristics but healed under the influence of simple home remedies or simple local applications prescribed by druggist or doctor.

The reason for the general chronicity of syphilitic leg ulcers is not readily apparent, but considering the fact that syphilis shows an especial predilection for the blood-vessels, and that syphilitic leg ulcers usually occur in persons of middle age or older, it seems highly probable that the chronicity of these lesions is dependent upon precisely the same factors which produce chronicity in varicose, tuberculous, and callous leg ulcers—factors which are not dependent upon the immediate cause of the lesion but are more or less fortuitous and have to do with the anatomical and pathological peculiarities of the lower extremities. These peculiarities have been discussed so often in connection with the so-called callous ulcer that they need not here be considered at length. The formula (1) weakened veins, (2) scanty musculature, and (3) poor blood supply, was so familiar to Coues,⁷ even in 1912, that he had grown tired of it. Likely enough, these three factors do not explain the matter satisfactorily, but I have no better to offer.

However, of this I am sure, that legs afflicted with chronic luetic leg ulcers frequently show tissue changes apart from the ulceration itself, which can best be explained on the basis of underlying vascular disturbances. I refer particularly to pigmentation, various skin rashes, and alopecia on the surface, and periphlebitis, ossification of soft tissues, periostitis, osteitis, and arthritis in the deeper structures. These changes have been noted by Wright⁸ and others as more or less characteristic of legs afflicted with chronic leg ulcers of other sorts.

At this point, some further mention should be made of the feasibility of using periostitis of the tibia and fibula as a differential point in the diagnosis of luetic leg ulcers. According to Coues,⁷ Post was the first author to point out the predilection of syphilis for producing periostitis of the tibia rather than other bones. At all events, periostitis of the tibia has come to be recognized as one of the well-known diagnostic signs of the disease, and many authorities place great store by it. It would seem reasonable, therefore, that

one of the ways in which to determine whether or not a given ulcer is luetic would be to examine a skiagram of the extremity for evidences of tibial periostitis. Unfortunately, however, there is a difficulty in the way of this simple diagnostic procedure in that it seems to have been demonstrated by many observers that any ulceration of the leg which has persisted long



FIG. 4.



FIG. 5.

FIG. 4.—S. T., aged fifty-four years. Cutaneous gumma right leg, anterior aspect, junction middle and lower thirds. Duration—five days; opened with a needle. Note circular contour, perpendicular margin, surrounding œdema due to secondary pyogenic infection. Patient has definite periostitis of both tibias, more noticeable in right tibia. Patient father of six children, only one living. Wassermann—negative. Indefinite history of (possible) primary lesion many years ago.

FIG. 5.—P. G., aged thirty-nine years. Multiple gummas of left leg, anterior aspect, junction middle and lower thirds. Duration of lesions—three months. History of penile ulcer, presumably chancre seventeen years ago. Wassermann—strongly positive. These lesions approach the type usually regarded as classical.

enough is associated with periostitis of the underlying bones, whether the ulcer is luetic or not. This observation has now been made by a sufficient number of observers to establish its truth beyond reasonable doubt.

SYPHILITIC LEG ULCERS

The earliest description of these changes which I have been able to find and perhaps also one of the most rational and complete is that by Coues,⁷ in 1912. He says that "long-continued ulceration of the leg, whether varicose, specific or undetermined, is often accompanied by extensive changes in the long bones, often only demonstrable by radiographs. These changes may be specific or non-specific." Morris⁹ described bone changes as well as changes in the blood-vessels and lymphatics in non-syphilitic ulcers. Carp,¹⁰ in 1921, described productive periostitis in connection with non-specific ulcers. He regarded this periostitis as due to a low-grade infection derived from the ulcer. The infection, he thought, might presumably occur either by direct extension of the inflammatory process or by way of the lymphatics, especially those which accompany the blood-vessels which supply the bone. Carp says that if the non-specific infection in any chronic ulcer "has persisted long enough, there is an extensive productive periostitis of either the tibia or the fibula, or perhaps both. If the ulcer is on the tibial side of the leg, low down, it will be noted that the periostitis is perhaps more marked immediately beneath the ulcer, but this is not necessarily true. There may be more evidence of it, röntgenoscopically, at the upper end of the tibia and, strange to say, involvement of the periosteum of the fibula. This productive periostitis at points distant and opposite to the ulcer is quite characteristic." He included reproductions of illustrative skiagrams. Skiagrams of extensive periostitis of the left tibia and fibula associated with osteophytic masses penetrating the interosseous ligament between the two bones are reproduced by Eloesser² from the case of a sixty-five-year-old man suffering from an ischemic ulcer, the result of a localized patch of arteriosclerotic gangrene. Coues⁷ thought that he could differentiate between cases of syphilitic and non-syphilitic periostitis. In the syphilitic cases, he found that the fibula was as likely, perhaps more likely, to be affected by periostitis as the tibia, and he stated that he accordingly attached great diagnostic significance to "roughening and thickening of any considerable part of the fibula." . . . "Roughness, general thickening, and much increased density of bone through a considerable length of bone are most suggestive of syphilis."

Although it would be very convenient indeed to have some entirely reliable means of differentiating syphilitic from non-syphilitic bone lesions, my own experience indicates that none has yet been devised. Indeed, one of the most harassing problems with which one can be confronted is the röntgenological differentiation between syphilis of bone, the so-called "sclerosing osteomyelitis of Garré," and certain varieties of early bone sarcoma, especially the periosteal sarcoma. I have examined a rather large number of skiagrams of legs in this series of cases with this point in mind, and have come to the following conclusions: (1) Not all leg ulcers which are both clinically and serologically luetic show definite periostitic changes of the underlying bones; (2) when such periosteal changes do occur, the syphilitic cases present an appearance virtually identical with that of the non-syphilitic cases in many instances; (3) when periostitis is demonstrable in legs with recent ulceration,

especially when the periostitis involves both bones of the leg, the presumption is that both processes are luetic. This is especially true if periosteum and underlying cortical reactions blend homogeneously on the skiagram.

Influence of Trauma.—Trauma is generally conceded to be a predisposing cause of luetic as well as other varieties of chronic leg ulcers. This has been mentioned particularly by Coues.⁷ In the present series of cases, a history of definite preceding trauma was obtained in 43 per cent. of the cases. The type of trauma varied somewhat but appears usually to have been of more than usual severity. It was occasioned in different cases by a sliver of wood, a dog bite, a train wreck, an automobile wreck, striking the leg with a hatchet, falling against a hot furnace, spilling hot ashes on the legs, and the like. Of course, the legs are portions of the body especially exposed to trauma, and accordingly the rôle of injury as a predisposing factor should not be interpreted too closely. It seems, however, that devitalization of tissue might very likely precipitate gumma formation inasmuch as it would serve as only another example of the appearance of a local manifestation of systemic disease at a "locus minoris resistentiæ."

THE RELATIVE DIAGNOSTIC IMPORTANCE OF A HISTORY OF PREVIOUS ULCERATION ON THE GENITALIA AND THE WASSERMANN REACTION

The statistical survey of the group of cases under discussion indicates that a primary penile ulcer, presumably syphilitic, occurred in 66 per cent. of the cases, only 44 per cent. being negative with respect to a history of a primary penile ulceration. The Wassermann reaction, on the other hand, would seem to be of much less significance; thus the ordinary hospital Wassermann reaction was positive in 37 per cent. of the cases, negative in 63 per cent. There is, of course, a very real danger in interpreting Wassermann-negative reactions too closely in any series of routine hospital cases. This is because there are many modifications of the Wassermann reaction which are in more or less common use in the hospitals throughout the United States, some of which are more sensitive and some less sensitive. When using the more sensitive reactions, scrupulous care must be exercised in the technical performance of the test lest false positive reactions inadvertently be obtained. In order to avoid such false positive reactions when using a sensitive variant, scrupulous care must be taken in the preparation and handling of reagents, and a relatively higher degree of intelligence and skill must be consequently required of the technician responsible for the performance of the test. Unfortunately, in hospital practice the technic of the Wassermann reaction is burdensome, and the source of revenue for the defraying of the expenses incident thereto so inadequate that it is not always possible to employ the most highly specialized technicians for this purpose. Consequently, it is rather customary, especially in the larger institutions, to select some modification of the Wassermann reaction, which is not particularly open to the danger of false positive reactions, and this sacrifice in the delicacy of the test undoubtedly and of necessity interferes with the detection of moderately

SYPHILITIC LEG ULCERS

weak reactions, which, if detected, might be of clinical significance when scrutinized in the light of clinical findings by an astute and careful practitioner. It is, therefore, quite possible that the incidence of positive Wassermann reactions in such a series as this might be increased somewhat by the employment of a more highly sensitive serological reaction. The author feels sure, however, that not even the most sensitive of such tests would increase the percentage of positive reactions in cases of luetic ulcer by any con-



FIG. 6.



FIG. 7.

FIG. 6.—F. L., aged forty-one years. Cutaneous gumma of the right leg, lower third, antero-medial aspect. Duration of lesion—six weeks. History of penile ulcer, presumably chancre, twenty years ago. Shape irregular in spite of duration, little evidence secondary infection, surrounding skin relatively normal. Wassermann—strongly positive.

FIG. 7.—E. B., aged twenty-seven years. Cutaneous gumma junction middle and lower third right leg, posterior aspect. Duration—six months. Began as a "pimple" which within three days became markedly swollen and reddened and was "opened by a doctor at the hospital with a knife." Active antiluetic therapy has failed to induce healing. Wassermann—weakly positive. Note irregular contour. Absence of reaction in surrounding skin; preservation of relatively typical appearance due to prevention of secondary infection. Regular out-patient care at hospital.

siderable amount, certainly not to such an extent as to make the percentage of positive reactions approach one hundred.

Further evidence in support of the greater reliability of the history over the Wassermann reaction is the fact that of those cases in which there was a disagreement between the history and the Wassermann reaction, those cases presenting a positive Wassermann reaction and a negative history represented

only 38 per cent. of the cases, whereas those cases with a positive history and a negative serological reaction represented 62 per cent. of the cases.

Chronicity.—In only 29 per cent. of the cases had the ulcer been present for one month or less; in 45 per cent. of the cases, two months or less; in 53 per cent. of the cases, three months or less; and in 65 per cent. of the cases, six months or less. Exactly one-quarter of the cases, *i.e.*, 25 per cent., had been present for more than one year; 12 per cent. had been present for more than five years. The duration of the oldest ulcer at the time of coming under observation was twenty-five years. There were five cases in which the duration had been twenty years or more.

In connection with these observations on the duration of the ulcer at the time of its initial observation in the clinic, an attempt was made to determine some correlation between the size of the ulcer and its duration. The surface area of the various ulcers was carefully computed, and the results were tabulated on coördinate paper with these values as ordinates and the duration of the lesion as abscissæ. The result was a typical "scatter" curve in which no correlation whatever could be demonstrated.

Age and Sex Incidence.—There is apparently universal agreement that the luetic ulcer is characteristically a manifestation of so-called "tertiary syphilis," and for this reason, the affection should be virtually a disease of mature individuals, inasmuch as syphilis is, to all intents and purposes, a venereal disease and is consequently contracted as a rule during the period of maximal sexual activity.

Possibly the age incidence in the particular series of cases which are here reported is not exactly representative of a cross-section of the general population, partly because of the sexual precocity of the Negro in general and partly because of the extremely great prevalence of the disease among the Negroes in this locality in particular. On the other hand, as Broeman⁵ very properly says: "Luetic ulcers may develop in young persons who are victims of congenital syphilis." Of the frequency with which this actually occurs with respect to ulcers on the leg, I have been unable to convince myself, but I have seen gummas of other parts of the body in presumably "innocent" young boys on numerous occasions, and partly for this reason, I am inclined to regard many cases of leg ulcer in young individuals as probably "innocent," even though the age of the subject is not such as to preclude the possibility of contact infection in the usual manner. In favor of this idea also is the fact that luetic ulcers occur as an extremely late manifestation of the disease; a matter to be discussed in more detail presently.

The average age incidence in the present series of cases was 39.8 years. By decades, the percentage distribution was as follows:

| | Per cent. | | Per cent. |
|-------------|-----------|-------------|-----------|
| 0-10 | 0 | 51-60 | 13 |
| 11-20 | 7 | 61-70 | 6 |
| 21-30 | 21 | 71-80 | 4 |
| 31-40 | 23 | 81-90 | 1 |
| 41-50 | 25 | | |

SYPHILITIC LEG ULCERS

The youngest patient in the series was fifteen years of age, the oldest eighty-two years of age.

These figures amply illustrate the fact that the chronic luetic leg ulcer is characteristically a disease of middle life, though it occurs both in youth and in old age. The age incidence of the lesion lends considerable support to the idea that one of the predisposing factors in the development of this form of ulcer is degenerative changes in the peripheral vascular system. Furthermore, although the changes just stated may have something to do with the matter just now to be mentioned, it is interesting to note that, as local manifestations of systemic syphilis go, the leg ulcer shows an unusually long latent period of development; *i.e.*, a long period of time usually elapses between the appearance of the initial lesion and the development of the ulcer. Broeman⁵ expressed the matter, though hardly strong enough, when he said that luetic ulcers occasionally develop soon after the development of the primary lesion or in young persons who are victims of congenital syphilis, but more frequently they occur late in the course of the disease. "They usually occur between the third and sixth year of the disease, but may begin at any time after the second year." Ochsner and Garside⁶ say that whereas luetic ulcers may occur at any time during the course of the infection (presumably these authors mean during the tertiary stage of the disease), they usually do not occur until two years after the initial lesion. In this series of cases, the average duration of time between the appearance of the initial lesion and the appearance of the ulcer in those cases in which the time interval could be computed with some accuracy was 16.3 years. In no case was the duration of time less than one year, in only 31 per cent. of the cases was there an interval of time of ten years or less, whereas in 69 per cent. of the cases, the latent period was ten years or more.

The universal teaching is that luetic ulcers are more common in the male than in the female, and this is in accord with what might be expected in view of the fact, also universally recognized, that syphilis itself is more frequently encountered in the male than in the female. Unfortunately, inasmuch as the clinical material from which the present series of cases was selected was entirely male, I have nothing new to add on this phase of the subject. White,¹ however, in a series of sixty-nine cases of chronic leg ulcer observed by him over a series of several years, found that of fifty-five cases in females, only five were judged syphilitic, and of fourteen cases seen in males, six were judged syphilitic. This is in accordance with the view shared by many observers that, although leg ulcers in general occur more frequently in the female than in the male, the syphilitic leg ulcer is particularly an affection of males.

It seems to be a common belief that syphilitic ulcers occur most frequently on the upper third of the leg. I have been unable to determine the source of this notion, but I cannot help feeling that it represents tradition rather than accurate observation inasmuch as in those published reports in which statistics can be found, there seems to be little substantiation for the idea,

and in my own experience, as reflected by the present study, it is by no means the case.

Steel¹¹ states that syphilitic ulcers are most common on the upper, outer half of the leg, but gives no statistics. Also Ochsner and Garside,⁶ without quoting statistics, say that "as gummata occur more frequently in the upper



FIG. 8.—F. C., aged twenty-eight years. Cutaneous gumma dorsum foot just above base right fifth toe. Duration—three months. Typical appearance. Note also linear ulceration just above ankle—also cutaneous gumma. Duration—one week. Patient was bitten by "ground rattler" at site of first lesion: as charm against poisoning, has worn tightly tied piece of bright-colored string at place of secondary ulceration. Wassermann—strongly positive.

third of the leg, it is at this site that syphilitic ulcer is most likely to occur." Broeman⁵ is a little nearer to what seems to be the truth, still quoting no figures, when he says that all luetic ulcers have a predilection for the region

SYPHILITIC LEG ULCERS

about the joints, the most frequent site therefore being the knee, but adds that a reasonably large number occur in the region of the ankle—or in another place, “any part of the leg” may be involved, the “calf of the leg usually,” though “the region of the knee” is most characteristic.

Goodman,¹² on the other hand, presenting a definite series of sixty-four cases of chronic leg ulcer, apparently all of which occurred on the lower parts of the legs, found thirteen ulcers of the twenty-five which occurred on the right leg to be associated with a positive Wassermann reaction and six (or eight) of the twenty-six ulcers which occurred on the left leg also associated with a positive Wassermann reaction. Wright⁸ is alone in stating what I have for some time been convinced is true, that even the definitely specific spirochætal ulcers of syphilis have a proclivity for the same area of the leg as the varicose or “indolent” ulcer.

In the present series of 100 syphilitic ulcers, only one case (1 per cent.) occurred in any part of the upper third of either leg. In tabulating the remaining ninety-nine cases, the legs were arbitrarily divided into middle and lower thirds from above downward and into four segments circumferentially—anterior, posterior, medial, and lateral. In the middle third of the leg occurred 19 per cent. of the cases, in the lower third 71 per cent., and on the foot 9 per cent. The circumferential distribution, considering both legs together and omitting fractions of a per cent., was as follows:

| <i>Middle Third Distribution</i> | | <i>Lower Third Distribution</i> | |
|----------------------------------|-----------|---------------------------------|-----------|
| | Per cent. | | Per cent. |
| Anterior | 40 | Anterior | 32 |
| Posterior | 10 | Posterior | 10 |
| Medial | 20 | Medial | 32 |
| Lateral | 30 | Lateral | 26 |

Goodman,¹² in an effort to discover whether the location of leg ulcers could be made to serve as an important point in the differential diagnosis, collected a series of sixty-four consecutive unselected cases from the surgical out-patient department of Bellevue hospital; apparently he included only ulcers which occurred on the lower parts of the leg. He found twenty-five cases with ulcers of the right leg, twenty-six with ulcers of the left leg, and thirteen with ulcers of both legs. In those cases with ulcerations of the right leg, a positive Wassermann reaction was obtained in thirteen of the twenty-five cases. In those cases with ulcerations of the left leg, a positive Wassermann reaction was obtained in six of the twenty-six cases, but two additional cases presented “slightly” positive reactions. In those cases presenting bilateral ulcerations, only two presented positive Wassermann reactions. Goodman concludes that “ulcers of the right leg are more apt to be syphilitic than those of the left leg, when the ulcers are limited to one leg.”

Goodman very properly points out that there seems to be no good *a priori* reason why gummas should show any special predilection for the right leg, whereas there is very good reason why ulcers of the left leg should predominate in any unselected series of cases: *viz.*, the predominance of varicosities,

and hence varicose ulcers, on the left lower extremity. In Goodman's series, syphilitic ulcers were uncounted twice as frequently on the right leg as on the left.

In the present series of cases, there is incomplete confirmation of Goodman's contention and little evidence at all to support the view that syphilitic ulcers are usually or characteristically bilateral. Thus, the right lower extremity was affected in 57 per cent. of this series of cases, and the left lower extremity in 43 per cent. of cases. In two instances bilateral ulcers were seen, but in both of these cases the ulcers were neither bilaterally symmetrical nor comparable in size.

I distinctly remember having seen in my past experience a certain number of cases of bilateral involvement in cases presumably syphilitic, but I feel sure such a condition is the rare exception rather than the rule, as this tabulated series indicates. In extenuation of the notion of bilaterality, it should probably be added, however, that a not infrequent finding is the occurrence of an open syphilitic ulceration on one extremity and a scar of a healed ulcer on the opposite extremity. In such cases, I have been in the habit of assuming that the scar represents a healed lesion of syphilis. This conclusion, however, I have never been able to substantiate by definite evidence. I doubt, in the light of the results in the present series, whether too much emphasis should be placed on the right-sidedness of luetic leg ulcers inasmuch as the preponderance of these ulcers on the right leg was really not very great.

Size and shape.—Probably the commonest teaching with respect to the size and shape of luetic ulcers is that they are small and usually multiple and they tend to show a crescentic shape or arrangement. Thus Strickler¹³ states that the syphilitic ulcer presents "an arrangement suggesting a segment of a circle." Ochsner and Garside⁶ mention the multiplicity of these lesions and the crescentic appearance. Broeman⁵ mentions also their multiplicity, but gives their shape as characteristically round. He says that the typical luetic ulcer consists of "thickly studded patches of ulcers"; the individual lesions vary in size from that of "a pea to that of a hen's egg or larger."

In the present series of cases, 35 per cent. of the lesions were multiple and 65 per cent. single. Of the 35 per cent. which were multiple, 26 per cent. showed two ulcers and 9 per cent. showed three ulcers or more. The average size, according to rough estimations, considering only the largest ulcer in those cases in which the ulcers were multiple, was 5.27 square inches. Twenty-nine per cent. showed a surface area of one square inch or less; 62 per cent., of two square inches or less; 71 per cent., of three square inches or less; 9 per cent., of between five square inches and ten square inches; 11 per cent., of ten square inches or more. Accessory ulcers were much more uniform in size, averaging one-half square inch. In by far the largest percentage of cases the ulcers were round or oval in shape. The remainder were irregular—sometimes very irregular. I can remember having seen very few luetic ulcers which could be properly called crescentic; certainly no instance occurred in this series.

SYPHILITIC LEG ULCERS

Undoubtedly there is some truth in Ochsner and Garside's⁶ contention that the size of luetic ulcers depends upon the amount of secondary infection which has occurred and the duration of that infection. Everyone who has had much contact with these lesions knows that they increase markedly and rapidly in size when neglected. On the other hand, it is equally true that this size may be variable from the outset, depending upon the size of the gumma to which the ulcer is secondary. It has been my good fortune on many occasions to watch the formation of these lesions from the stage of early gumma formation, and it is certainly true that not all gummas on the leg or on any other part of the body are of uniform or even nearly uniform size at the time they liquefy and ulcerate.

Appearance of floor, edge, and surrounding skin.—The floor of the syphilitic leg ulcer in the earliest stages of the lesion is smooth. In those cases in which the gumma from which the ulcer originated was subcutaneous, the floor may consist of the external surface of the underlying muscles and, as previously mentioned, the muscle fibres may be seen as distinctly as if they had been exposed by careful dissection. In those cases in which the gumma was originally cutaneous rather than subcutaneous and in those locations in which the subcutaneous fat is thick, the floor of the ulcer may consist of subcutaneous fat. In this case, the floor is smooth as before but covered by a thick, distinctly yellow, slime which may be torn away in shreds but is extremely tenacious and stringy. As the lesion becomes older, the appearance of the base of the ulcer is apt to become altered by secondary infection or by vigorous or abortive attempts at granulation tissue formation. Unless secondary infection becomes marked, the secretion from the luetic ulcer is apt to be thin, grumous and relatively scant.

The edges of the luetic leg ulcer present a "punched-out" appearance which is very characteristic. The gumma in which the ulcer originates separates from adjacent tissue cleanly, leaving an ulcer wall or edge which is roughly perpendicular to the skin surface.

The skin surrounding a luetic ulcer early presents a relatively unaltered appearance. There may be slight redness in case secondary infection has occurred, but pigmentation, eczema, and excoriation of the surrounding skin do not usually appear except as a result of long-continued irritation by secretions from the lesion.

Treatment.—As probably everyone will agree, the treatment of the chronic syphilitic leg ulcer is partly medical and partly surgical and as in many another therapeutic problem on the boundary line between medicine and surgery, it is difficult to say where the proper usefulness of medicine ends and the advisability of surgical attack begins.

Medical treatment.—All will probably agree on the importance of medical treatment for the systemic disease, even those who feel that the influence of this treatment on the local lesion may not be great. As previously mentioned, my personal experience leads me to the conviction that anti-syphilitic treatment is by no means all that is required in the majority of cases. In

those cases which occur in young individuals, it may be rapidly and completely curative, but in older individuals in whom secondary changes have occurred in the blood-vessels of the extremities, it may induce relatively little healing. Certainly I cannot agree with those who think that vigorous anti-syphilitic treatment is specific, for these lesions and failure of the lesions to heal promptly under such therapy is an adequate reason for questioning the correctness of the diagnosis.

An extended discussion of the principles and practice of anti-syphilitic therapy need not be attempted in this connection. The literature on the subject is stupendous and the opinions of authorities do not coincide in some major and many minor matters. The arsphenamines and mercury have so far commended themselves to the profession as to have virtually come into universal use as anti-syphilitic therapeutic agents. Arsenic has been in more or less constant use in the treatment of syphilis from the time of Fallopius (1523-1562), first in the form of ordinary white arsenic (arsenious acid), then as Fowler's or Donovan's solution, still later as atoxyl (sodium para-aminophenylarsenate), and since 1910, as salvarsan and neosalvarsan (the arsenobenzols).

With respect to the relative efficiency of salvarsan and neosalvarsan, my experience leads me to believe with Burke¹⁴ and others that there can be no question but that salvarsan is a more powerful spirocheticide than neosalvarsan. This fact was impressed upon me originally while a surgeon in the United States Navy. On shipboard, neosalvarsan was the only preparation available; at shore stations salvarsan alone was used; the superiority of the treatment ashore was beyond question. The same fact has been illustrated more recently in a serological study* in which the Kahn precipitation reaction was performed on a rather large series of unselected cases for purposes of statistical survey. Those cases in the group which were not under active treatment at the time but had previously been treated with neosalvarsan almost invariably presented a positive reaction regardless of the number of doses of the drug given or the time interval between the last injection and the performance of the test.

Mercury is a therapeutic agent so universally accepted as to need no especial mention.

Bismuth, a younger agent therapeutically, seems to be gaining increased confidence in the profession with the passage of time and appears definitely to belong in the category of valuable anti-syphilitic drugs.

Wallace,¹⁵ of Dublin, in 1836, was apparently the first physician to use iodine in the treatment of syphilis, but Ricord¹⁶ popularized the use of the drug in the treatment of the disease in its tertiary stage. This drug differs from those named previously in that it is not of value as a combatant of the syphilitic infection *per se*. Burke¹⁴ says in this connection: "It cannot be too strongly insisted upon that iodine and the iodides possess no treponemicidal power. . . . Neither iodine nor its salts are treponemicides. Their real func-

* Unpublished.

SYPHILITIC LEG ULCERS

tion lies in their power of breaking down the fibrous-tissue fortifications behind which, especially in late and endosyphilis, the organism has established itself. Iodides are solvents of fibrous tissue." With the discussion of the rationale of iodine medication, therefore, the subject of discussion changes from the systemic disease to the local lesion.

The pathology of syphilitic ulcers has already been discussed and the reaction by which fibrous connective tissue comes to surround the lesion and interfere with the blood supply and the healing process in general has been mentioned. The value of iodine medication in the healing of luetic ulcers, so far as it is certainly known, is in direct proportion to its ability to release this fibrous connective-tissue fortification and allow the formation of healthy granulation tissue and the speeding of new epithelial covering from healthy marginal skin. It requires but a moment of reflection on the histological picture of the lesion to realize that the drug is likely to be of most value in the earlier lesions in which the amount of fibrous tissue is not great, since it is a matter of common knowledge and experience that no drug can be relied upon to correct extensive histological changes. Furthermore, it has been the experience of the author, and doubtless the experience of most or all of those who have had any considerable experience with luetic ulcers, that ordinary doses of iodine are of little or no value, even in lesions in which there is a relatively small amount of fibrosis.

By ordinary doses is meant the equivalent of five, ten or fifteen grains of potassium iodide three times per day. To be sure, doses of this size can conveniently be used at first to determine the possible sensitivity of individuals to iodides and to accustom them to the régime of iodine therapy, but to make iodide therapy effective, it is usually necessary to increase such doses many-fold. It has been the author's practice to prescribe a saturated solution of potassium iodide by mouth in initial doses of ten, or, more frequently, fifteen minims three times a day, dissolved in water or preferably in milk, three-quarters of an hour to an hour after meals (in order to minimize the irritant effect of the drug on the gastric mucosa) and then to increase the dose by several drops at intervals of two or three days until the patient takes three times a day from sixty grains of potassium iodide upward. It might be supposed that such doses would predispose to the rapid development of iodism, but experience indicates that such is actually not the case. On the contrary, individuals who are seemingly intolerant to the smaller doses of the drug frequently find no difficulty in taking and assimilating the larger doses without toxic effects of any kind. Some of the author's patients have taken and are taking between 1 and 200 grains of potassium iodide three times a day in this manner. Doses of 500 to 1,000 grains three times a day can be taken at least by certain patients if such doses seem to be warranted. Such doses are rarely or never indicated for patients with syphilitic leg ulcers but are quite routinely given in cases with actinomycotic infections, a fact which is here mentioned simply to substantiate the feasibility of using relatively large doses of the drug.

Lately I have been using sodium iodide intravenously in some cases. The series of patients from which the particular cases under discussion were taken are the poor and indigent, not to add the ignorant and slovenly. The cost of potassium iodide in the case of some of these patients is a serious financial burden and in some cases is actually prohibitive. Although it has usually been possible for those without financial means of their own to procure the drug through charitable sources without cost, nevertheless the amount procurable at any one time has invariably been so small as to discourage the patient in replenishing his stock as it became exhausted. The result has been that in some cases I never could feel quite sure that although the drug had been ordered, it had been actually procured and taken by the patient according to instructions. Accordingly, in those cases in which I had reason to believe that the iodine medication was not being scrupulously followed, I have adopted the intravenous method. Smaller doses have been given in the beginning, but the average therapeutic dose is the contents of a twenty-cubic centimetre ampoule of sodium iodide in 5 per cent. solution; *i.e.*, about thirty-three grains. The injection is, of course, made under aseptic precautions and proceeds very slowly. To insure this latter state of affairs, I prefer to inject with a small hypodermic needle. In a few cases, I have seen syphilitic ulcers heal promptly under intravenous iodide therapy, although they had been quite resistant to treatment *per os*.

Adequate anti-syphilitic treatment, *i.e.*, the adequate usage of the arsphenamines, mercury, bismuth and the iodides, does not by any means invariably lead to marked improvement in the local lesion. I have seen recent ulcers in patients with strongly positive serological reactions heal very kindly and rapidly under the influence of vigorous treatment by these drugs. I have seen ulcers of longer duration in syphilitic patients improve slightly under such medication, and I have seen other ulcers, both of long and short duration, which appeared to be absolutely uninfluenced by the anti-syphilitic treatment, in spite of the fact that they were definitely luetic by every rule of diagnosis. Although, therefore, anti-syphilitic treatment and the use of iodides in large doses is indicated in every case of syphilitic ulcer or suspected syphilitic ulcer, the results of such medication may or may not be satisfactory. In my experience, I have found that in only a relatively small proportion of really chronic cases could this form of medication, no matter how vigorously pushed, effect a cure of the lesion. If it were not so, there would be no excuse for the considerable literature which has grown up on the subject of therapy.

Local treatment.—Local treatment of syphilitic ulcers is designed to accomplish one or the other or both of two ends: (1) To control secondary infection, and (2) to promote healing.

Because of the fact that the syphilitic ulcer is a relatively painless lesion, that it occasions no incapacitating disability, and that it may not be unduly large at first, patients in straitened circumstances, patients possessed of limited intelligence, and those careless in matters of personal hygiene, fre-

SYPHILITIC LEG ULCERS

quently undertake the treatment of the early lesion themselves, and only after they have exhausted their own resources and those of their immediate and sometimes more distant acquaintances, may they present themselves to a physician for treatment. For this reason, most syphilitic ulcers at the time they first come under observation present all the manifestations of secondary infection. For the same reason, many of these lesions also present a thickened, indurated, fibrotic base and edges; in short, a picture not essentially different from that of the so-called "callous" ulcer. It is only by carefully rationalizing the local treatment with reference to the specific ends to be accomplished that one can hope to achieve ultimate success.

To those of limited experience and, to some extent, also to those who have grown weary in the treatment of chronic leg ulcers, the selection of suitable medicinal agents and the technic of the application of those agents to the local lesion may seem of considerable importance. There are still many who talk and write enthusiastically about salves, ointments, lotions, pastes and powders. I have yet to see the more commonly used and better known of these agents do any gross harm, but I have tried numbers of them and have seen many different preparations used by others without improving the patient's condition at all, and this in spite of the fact that the patient's reaction was almost invariably in favor of the preparation most recently used in his case. The patient with the chronic leg ulcer almost constantly has an optimistic attitude, and I believe that it is in some part, at least, the contagion of this attitude which has prompted the enthusiastic endorsement of such preparations by the medical profession itself in the past.

If these agents are used for their germicidal value, the confidence of the person who uses them is almost certainly misplaced. It is now pretty generally accepted that effective germicides destroy the tissue of the host with the same measure of avidity with which they destroy the bacterial invaders, and, indeed, were it not so, germicides applied to surfaces are capable, in the very nature of events, of destroying only the surface bacteria. These bacteria, furthermore, are precisely those bacteria which cause no real harm, only those bacteria which have been engulfed by actively motile polymorphonuclear leucocytes and have been carried into the deeper tissues by way of the lymphatics being in a position to do active harm. Those applications which are bacterially inert may be harmless or harmful, depending upon their physical characteristics.

Ointments and salves tend to keep dressings from adhering to the ulcer and allow more or less free motion of the skin below the dressing while the dressing is in place. For this reason, they are soothing, and to some extent facilitate redressing from time to time. If, however, there is an active infectious process in the ulcerated tissue, the advisability of smearing the area with any substance impervious to water seems to be somewhat at variance with the accepted principle of treating infections. The case for powders and lotions belongs in the same category.

In the light of war-time and post-war-time experience, it would seem that the rational method of procedure in any open infected lesion is the method which has sometimes been called "physiological antiseptis." This consists of the application to the lesion of sterile compresses of hypertonic salt solution, preferably in the case of such lesions as chronic leg ulcers, in the form of hot sterile gauze compresses. The rationale of the hypertonic salt solution compress cannot be detailed in this place and still preserve the proper equilibrium of the discussion, but Fleming's¹⁷ excellent discussion on "The Action of Chemical and Physiological Antiseptics in Septic Wounds," though published in 1919, is still a classic and worthy of the perusal of anyone interested in the subject.

The control of sepsis in syphilitic ulcers is usually not difficult when using this method. My custom is to instruct the patient to procure a clean basin, preferably a new earthenware basin, and to fill with water, using a clean quart milk bottle to measure the amount of water added, then to add to the water two heaping tablespoonfuls of common salt (sodium chloride) or four heaping tablespoonfuls of epsom salts (magnesium sulphate) for each quart measured, then to place the basin or pan over the fire and boil the solution, subsequently allowing it to cool somewhat before use. The patient is then directed to pour this solution over a voluminous dry gauze bandage previously applied in the clinic. Such a solution contains about 6 per cent. of the salt added and is sufficiently hypertonic. Boracic acid is considerably less soluble even in saturated solution and incidentally is somewhat more expensive. For these two reasons, I do not consider it particularly suitable. Patients are usually instructed to make applications at intervals of one hour and to keep the dressing saturated with the hot solution for a period of half an hour at a time. Within a few days, if this treatment be persistently followed, almost any leg ulcer, even though grossly infected, can be very effectively sterilized.

For the stubbornly resistant varieties of infected ulcer, there is no alternative but to put the patient to bed, subject him to permanent elevation of the affected part, and treat the local lesion vigorously according to the principles previously enunciated as suitable for ambulatory patients until the process is well under control. I have never seen a case of luetic leg ulcer so badly infected that it failed to respond to this form of treatment. When local infection has once been brought under complete control, every effort should, of course, be made to prevent secondary contamination and an exacerbation of the original infectious process.

With the sterilization of the ulcer, the therapeutic goal changes to the stimulation of the process of repair. As all those who have had much experience with the treatment of chronic leg ulcers know only too well, the medicinal agents, ointments, powders and lotions previously mentioned as being inefficient in the control of infection are even less efficient in the stimulation of the process of repair. This process is essentially one of the growth of new connective tissue and new epithelium to fill the hiatus left by the detachment of the gumma. Inasmuch as the growth of both varieties of tissue is dependent

SYPHILITIC LEG ULCERS

upon adequacy of blood supply, no form of treatment can be expected to succeed which fails to take into consideration and overcome the tissue changes which militate against adequate vascularization of the area.

In many cases, failure of the lesion to heal seems to be due mainly to a more or less chronic venous congestion of the part, and this is frequently associated with some degree of localized or generalized tissue œdema. If all cases showing such vascular disturbances could be put to bed immediately and then could be actively treated by elevation of the part and the application of dry, or, better, moist heat, probably healing would progress rather satisfactorily in many instances. The nature of the lesion, however, and frequently also the financial status of the patient as well is too often such that this form of treatment is considered impracticable.

Altogether too frequently when this conclusion has been reached, it is tacitly assumed that nothing can be done for the vascular disturbance. The attendant's attention becomes focussed on the local lesion and the condition of vascular embarrassment receives no attention at all. Inasmuch, however, as the healing of leg ulcers depends upon adequate vascular circulation not only of arterial and venous blood but also of lymph, such an attitude is invariably detrimental to the patient's interests, and the local lesion goes rapidly from bad to worse, regardless of the painstaking regularity with which dressings may be applied.

It cannot be too strongly emphasized that much can be done for the patient whose leg ulcer is associated with vascular stasis of the extremity, even though such a patient cannot or will not submit to prolonged recumbency. The problem in the ambulatory patient may be attacked from the following points of view: (1) That of lymph stasis, (2) that of arterial blood supply, or (3) that of lymph stasis and venous stasis conjointly. The procedures which may be adopted are: (1) Lymphangioplasty for the lymph stasis, (2) a Leriche procedure to increase the arterial blood supply, or (3) the application of some form of molded elastic support to the extremity to combat both lymph stasis and venous stasis. The first two procedures are only in the experimental stage and seem to the author to offer very little prospect of benefit in most cases of luetic leg ulcer. The last procedure is technically less difficult and from the practical point of view proves exceedingly efficacious in many cases.

Lymphangioplasty.—According to Mason,¹⁸ the important prerequisite for the healing of chronic ulcers of the leg is the institution of adequate drainage for tissue fluid which accumulates in the tissue spaces surrounding the ulcer. Thus, when Mason speaks of drainage, he does not mean superficial drainage of the ulcer surface, but a drainage of the sodden tissues forming the ulcer bed. He calls attention to the fact that although lymphangioplasty has not been accepted as a proper form of treatment for œdematous legs, the seat of chronic ulceration, the operation has been applied with benefit by both Handley¹⁹ and Clark²⁰ in the treatment of œdema of the leg without ulceration. He refers to the classical work of Kondolion and states that the object

of lymphangioplastic operations is to form an artificial means of communication between the superficial lymphatic chain of vessels which course superficial to the deep fascia, and the deep chain of lymphatics which course deep to this fascia, there being normally no considerable intercommunication through the fascia itself; the fascia forms a tubular investment for the muscles of the leg and thus separates rather distinctly the one group from the other. Mason's operation is a rather simple one. He uses two or three pieces of No. 12 silk suture material. He passes the silk on a probe through the superficial œdematous tissues, to and through the deep fascia into the deep muscular plane; he allows these pieces of silk to remain *in situ* until new lymphatic channels have been created along the course of the silk ligature as a guide. He emphasizes the importance of assuring one's self that the deep ends of these pieces of silk have actually been thrust deeply into the musculature and have not been allowed to become subsequently displaced into the subcutaneous tissues. Mason has treated several cases of chronic callous ulcers in this manner with apparently excellent results. The author has never had occasion to try the method, but it would seem to be entitled on the basis of common sense and Mason's endorsement to further trial by other persons who have to deal with the ulcer problem.

Operations on the sympathetic supply to the part.—The popularization by Leriche²¹ of the idea that the operation of periarterial sympathectomy is capable of markedly increasing the arterial blood supply to the extremities has stimulated much experimentation with respect to the potentialities of the operation in the treatment of a variety of conditions. Chronic leg ulcers have been no exception. It was the teaching of Leriche that the operation of periarterial sympathectomy causes interruption of the vasoconstrictor nerve fibres supplying the part of the body distal to the site of operation and thereby tends to flood the part with arterial blood. Ford²² conceived the idea that such an augmentation of the blood supply of the lower extremity was precisely what seemed most needed in the treatment of chronic leg ulcers. Ford thought, however, that actual periarterial sympathectomy performed with a knife might be less successful in accomplishing this end than a somewhat more simple procedure; *vis.*, the interruption of the periarterial sympathetic nerve trunk by chemical means. Following the lead of Sampson Handley,¹⁹ who produced chemical section by injection of alcohol into the wall of the artery, Ford proposed this practice in the treatment of leg ulcer since it would seem to be simpler than section with a knife and also since Leriche had apparently shown that the vasodilator effect of mechanical sympathectomy was transient, not lasting for more than a month at best. Arguing from the premise of the prolonged effect of alcohol injections in the treatment of trigeminal neuralgia, Ford thought that the use of alcohol should produce a more prolonged reaction. Although Ford tried this procedure clinically in but one case, the results in this case were particularly gratifying and he expressed his intention of making the procedure an object of further assay.

SYPHILITIC LEG ULCERS

Mechanical supports to the vascular system.—When attempting to produce conditions favorable to the repair of chronic leg ulcers by the use of artificial supportive devices to the part, attention should be paid to the fact that the end to be achieved is support to the entire vascular system of the extremity below the knee. Local supportive devices applied to the region of the ulcer alone are of relatively little value because the vascular disturbance itself is not limited to the area of ulceration. Accordingly, the local application of such devices as “crisscross,” or “basket,” strapping of the ulcer with adhesive plaster and the local use of elastic pressure, as by balloons or pieces of rubber sponge, is apt to be disappointing. On the other hand, any mechanical appliance which provides firm and even elastic pressure to the tissues from the base of the toes to the bend of the knee is almost sure to be of great benefit.

The elastic stocking is a good example of such a device, but due to the original expense of obtaining a stocking with an accurate “fit,” the fact that the fabric of which it is made is apt to deteriorate and the contour of the part is apt to change, and other considerations, the elastic stocking is not by any means an ideal appliance.

Various substitutes for the elastic stocking have been devised, some of which are deserving of a word of mention, especially the washable rubberless elastic bandage and elastic adhesive plaster.

There are two contrivances, however, which are very efficient, can be made available anywhere, and do not place the surgeon at the mercy of any manufacturer or distributor of special apparatus—the adhesive-plaster strapping of Gurd²³ and the plaster stocking or boot of Unna.

Gurd’s procedure supersedes most other devices in efficiency, particularly if elastic adhesive plaster is used instead of ordinary adhesive plaster. The procedure which he recommends is as follows: The leg is thoroughly bathed in a solution of washing soda and is thereafter thoroughly scrubbed with soapy water and a soft brush. The leg is then washed with petroleum ether either immediately, or after the application of alcohol; the purpose of the alcohol is to dehydrate the superficial layers of the skin. The patient then is required to lie on his back with the leg elevated nearly perpendicularly against the wall for a period of from thirty minutes to two hours or until all œdema has disappeared. With the leg still elevated, strips of zinc oxide plaster, from 2.5 to 3.5 centimetres in width and sufficiently long to overlap when passed circularly about the leg, are applied beginning at the base of the toes and ending just below the knee; successive circular strappings are made to overlap the preceding one by at least 1.5 centimetres. The strapping is carried directly over the ulcerated area. Gurd says that the heel need not be covered but makes an especial point that the strapping should extend upward on the leg as far as the attachments of the fascia to the tuberosities of the tibia and the head of the fibula. Such an appliance lasts on first application from about four to ten days; thereafter, it is usually effective if changed only every two or three weeks. Reapplications of the dressing follow exactly the same routine as the first application.

When properly applied, the Unna's plaster stocking is by far the best device of all. Many of those who have contributed to the literature on the subject of chronic leg ulcer have spoken very highly of this device (White,¹ Thomas,²⁴ Strickler,¹³ Eloesser,² Ochsner and Garside.⁶ The method of preparation and application of this device has been described in a number of different places and need not here be repeated.* Among other advantages, this device possesses the following: (1) It is semi-elastic and yet rigid; (2) it is relatively inexpensive; (3) it can be prepared and applied by almost everyone and almost anywhere; (4) it is a custom-made device which fits the part perfectly and provides diffuse but adequate support over the entire extremity below the knee; (5) it is fashioned to fit the individual patient, being molded to the shape and size of his particular extremity; (6) it cannot be removed and replaced by the patient without the knowledge of the physician; (7) when it becomes soiled or ceases to perform its proper function, it is cut away and discarded without hesitation or compunction, because it is relatively cheap.

Plastic operation.—Plastic operations attempt to attack the problem from a much more direct angle than any of the preceding forms of treatment. The problem is immediately shorn of much of its technical difficulty by the assumption that the essential features in the case are a denuded area of the body, which the body is unable to fill in the usual manner with granulation tissue and epithelium by virtue partly of its size, partly of its location, and partly because of other factors, chiefly a zone of fibrous connective tissue interposed between the ulcer itself and the adjacent normal tissues from which vascularization and the formation of new tissue must in the nature of events eventually come.

It is assumed by those who advocate plastic operations that chronic syphilitic leg ulcers can be cured like other lesions which involve extensive destruction of tissue by careful skin grafting of the area after adequate preparation of the field for grafting. I am well aware that the solution of the problem is probably not actually as simple as it looks at first glance, but largely because of the pioneer work of such surgeons as Long,²⁵ Carnett,²⁶ Douglas²⁷ and others, I have come to believe that the idea of primary grafting in the case of chronic syphilitic ulcers is fundamentally sound and should be more frequently adopted. I am strongly of the belief that luetic ulcers larger than one inch in diameter should be subjected to skin grafting just as soon as adequate anti-syphilitic treatment has been provided and infection has been controlled, without waiting to determine what effect other forms of local treatment may have. Furthermore, I am convinced that all ulcers, even though they be much smaller than this, should be subjected to skin grafting within a month or six weeks, provided they do not show a rapid tendency to heal under the ordinary forms of treatment previously described.

* Anyone to whom the Unna's paste boot is unfamiliar is referred to: Cutting, R. A.: Chronic Leg Ulcers. Treatment with Unna's Paste Boot. Amer. J. Surg., vol. viii, p. 743, 1930.

SYPHILITIC LEG ULCERS

I do not, however, believe that skin grafting will assume its legitimate place in the treatment of this condition until the following facts are realized: (1) That patients with chronic leg ulcers are properly subjects for the early attention of the surgeon and are not to be referred to him only after long-continued conservative treatment has been tried in vain and has vitiated his best opportunity to be of use; (2) that the patient with chronic leg ulcers has as much right to a bed in a hospital and as great a claim on the time and study of the surgeon as does the case with chronic osteomyelitis, acute appendicitis, cholecystitis, or any other of the surgical maladies which keep the ward beds in a hospital filled; (3) that hospitals and doctors alike profit as much by adopting a form of treatment which promises an early successful result as does the patient, because otherwise the repeated calls of the patient on the time of the staff or the individual, as the case may be, actually consumes a far greater amount of time and material—in other words, expense—than a concerted marshalling of medical resources for a relatively short period of time at the outset.

Half-hearted attempts at plastic repair of chronic leg ulcers cannot be expected to yield a high percentage of satisfactory results; by this I mean the somewhat grudging admission of the patient to the hospital for a few hours of preliminary treatment, the spreading of Thiersche grafts over the base of the ulcer without due regard to underlying tissue changes, and the early dismissal of the patient to an out-patient service for subsequent care. It is true that a certain percentage of patients treated in such a manner are temporarily relieved of their open ulceration. A very thin pellicle of unhealthy-looking bluish epithelium spreads over the base of the ulcer. An unsatisfactory form of repair, however, occurs beneath this thin pellicle of epithelium which consists of maximal scar production, the result being that contraction of the part subsequently ensues; the blood supply to the new epithelium gradually becomes inadequate and sooner or later some minor scratch or abrasion at the site of the old ulceration serves to rekindle the original process, and the entire area reulcerates.

In order to perform the operative procedure properly, it is necessary to admit the patient to a hospital in good faith for a period of time as long as may be required to study his individual case and completely rehabilitate the patient. The first few days of stay in the hospital, apart from the routine matters associated with the elaboration of an adequate physical examination, consist of relieving the affected extremity of oedema and engorgement by constant elevation of the part on pillows. At the same time, any associated secondary infection of the ulcer is energetically treated, either by the use of hot hypertonic salt-solution compresses, or, perhaps even better in certain cases, by the Carrel-Dakin technic.

As soon as the clinical manifestations of secondary infection have subsided, daily bacterial examinations are made until the bacterial count in the lesion indicates that it is ready for an operative procedure and that this procedure can be performed without danger of rekindling latent infection. As

soon as this condition has been found to exist, the surgeon dons a pair of sterile gloves and proceeds to determine by careful manipulation of the area the extent of the preliminary excision of tissue which must be made in order to provide a satisfactory bed for subsequent grafting. The amount of tissue which must be cut away depends upon the amount of fibrosis which has occurred, for sufficient tissue must be removed to expose a relatively normal and adequately vascularized area from which healing can take place. By grasping the margins of the ulcer between thumb and finger of the gloved hand and by gentle exploration of the base of the ulcer with the examining finger, a very satisfactory determination of this point can be made rather speedily. The first stage of the operative repair can now be completed. This consists merely in the excision of the required amount of tissue and the control of hæmorrhage from the base of the new ulcer thus created. Sterile dressings are then applied to the area and the patient is returned to the ward, whereupon the limb is elevated as before and the new ulcer is allowed to fill for a number of days with clean, healthy, non-infected granulation tissue.

The amount of time required for this process varies considerably, but frequently consumes two or three weeks. During this period of time, if the granulation tissue tends to become exuberant, it may be slightly cauterized with a stick of fused silver nitrate, or if the granulations appear soft and friable, they may be stimulated and hardened by the application of sterile hypertonic sodium chloride solution in a strength of about 10 per cent. As soon as it is believed that a good bed of granulation tissue has developed, the patient is again taken to the operating room for the last stage of the operation, which consists of the actual grafting.

The type of skin graft to be used will undoubtedly vary with the individual preferences of the operator. The thick and the thin, the small and the large grafts, all have their advantages and disadvantages, and it is only by a careful weighing of these advantages and disadvantages in any given case that the operator can determine the proper methods for use. The pedicle graft would be ideal if the area to be grafted were the only consideration. Unfortunately, about the only place from which a pedicle graft could be taken in these cases would be the same or the opposite leg. If the opposite leg is chosen and it has a defective blood supply, the pedicle itself is apt to slough before it takes, and in any case, a large defect is left on the sound leg which must subsequently be made to heal or else the patient simply exchanges a chronic ulcer on one leg for a chronic ulcer on the other. The Thiersche graft usually takes well and leads to healing in a relatively large number of cases. However, the resulting layer of protective epithelium is thin; it becomes injured easily and it resists infection poorly. The small deep graft usually takes satisfactorily, but it produces an unsightly scar and it fails to prevent contractures from developing. Full thickness grafts are ideal from the points of view of healing, cosmetic effect, and prevention of contracture, but they may easily be completely lost if post-operative infection occurs.

All of these objections, however, are merely relative, and considering the

SYPHILITIC LEG ULCERS

highly unsatisfactory character of other kinds of treatment for the resistant luetic ulcer, even a poor choice in the matter of skin grafting methods often results in a relatively satisfactory end-result.

BIBLIOGRAPHY

- ¹ White, E. P.: Ulcers of the Legs, Miscalled Varicose: A Clinical Review. *Brit. J. Dermat. and Syphl.*, vol. xxx, p. 138, 1918.
- ² Eloesser, L.: Leg Ulcer. *S. Clin. N. America*, vol. ii, p. 537, 1922.
- ³ Cutting, R. A., Loria, F. L., and Pickell, F. W.: Syphilis Among Southern Negro Males. *ANNALS OF SURGERY*, vol. xci, p. 269, 1930.
- ⁴ Stokes, J. H.: Clinical Syphilology. W. B. Saunders Co., Philadelphia, September, 1926.
- ⁵ Broeman, C. J.: Chronic Leg Ulcer. *Am. Physician*, vol. xxvii, p. 272, 1922.
- ⁶ Ochsner, A., and Garside, E.: Chronic Leg Ulcers. *Texas State J. Med.*, vol. xxv, p. 587, 1930.
- ⁷ Coues, W. P.: The Bone Lesions Accompanying Chronic Leg Ulcers. *Boston M. and S. J.*, vol. lxvi, p. 414, 1912.
- ⁸ Wright, A. D.: The Treatment of Indolent Ulcer of the Leg. *Lancet*, vol. ccxx, p. 457, 1931.
- ⁹ Morris, D.: The Deeper Structural Changes Arising from Various Ulceration. *Surg., Gynec., and Obstet.*, vol. xxx, p. 72, 1920.
- ¹⁰ Carp, L.: Some Phases of Leg Ulcer. *Am. J. Surg.*, vol. xxxv, p. 180, 1921.
- ¹¹ Steel, W.: The Treatment of Varicose Leg Ulcer. *Internat. Clinics*, vol. iv, p. 295, 1922.
- ¹² Goodman, H.: Ulcer of the Leg: Its Localization as a Point of Differential Diagnosis. *Arch. Dermat. and Syph.*, vol. vi, p. 179, 1922.
- ¹³ Strickler, A.: Text-book on Diseases of the Skin and Syphilis. F. A. Davis Co., p. 337, Philadelphia, 1927.
- ¹⁴ Burke, E. T.: Treatment of Venereal Disease in General Practice. Oxford University Press, vol. liii, p. 50, London, 1927.
- ¹⁵ Wallace: Quoted by Burke.
- ¹⁶ Ricord: Quoted by Burke.
- ¹⁷ Fleming, A.: The Action of Chemical and Physiological Antiseptics in Septic Wounds. *Brit. J. Surg.*, vol. vii, p. 99, 1919.
- ¹⁸ Mason, J. T.: Lymphangioplasty in the Treatment of Some Leg Ulcers. *Northwest Med.*, vol. vii, p. 320, 1915.
- ¹⁹ Handley, W. S.: Peri-arterial Injection of Alcohol in Senile Gangrene. *Lancet*, vol. ii, p. 173, 1922.
- ²⁰ Clark, W.: Quoted by Mason.
- ²¹ Leriche, R.: Some Researches on Periarterial Sympathetics. *ANNALS OF SURGERY*, vol. lxxiv, p. 385, 1921.
- ²² Ford, R. K.: A Note on the Treatment of Chronic Ulceration of the Lower Extremities. *Lancet*, vol. i, p. 1005, 1923.
- ²³ Gurd, F. B.: An Ambulatory Treatment for Chronic Leg Ulcers. *Canad. M. A. J.*, vol. xi, p. 815, 1921.
- ²⁴ Thomas, B. A.: The Treatment of Leg Ulcers. *Univ. Penna. Med. Bull.*, vol. xxiii, p. 365, 1910.
- ²⁵ Long, L.: Extensive Ulcer of the Leg; Skin Grafts. *J. Okla. M. A.*, vol. xv, p. 121, 1922-1923.
- ²⁶ Carnett, J. B.: The Treatment of Chronic Leg Ulcers. *S. Clin. N. America*, vol. viii, p. 815, 1928.
- ²⁷ Douglas, B.: The Radical Repair of Large Skin Defects with Particular Reference to Leg Ulcers. *Southern M. J.*, vol. xxiv, p. 53, 1931.

TRANSACTIONS

OF THE

NEW YORK SURGICAL SOCIETY

STATED MEETING HELD MARCH 9, 1932

The President, DR. JOHN DOUGLAS, in the Chair

BLEEDING DUODENAL ULCER—RECURRENT

DR. EDWARD J. DONOVAN presented a man, aged twenty-four years, who was admitted to the Medical Ward of St. Luke's Hospital, January 8, 1932, with a history of having been operated upon in another hospital May 13, 1929, for perforated duodenal ulcer. Previous to this he had had ulcer symptoms for about one year. A simple closure of an anterior-wall duodenal ulcer was done. One year later he began to have his old distress after eating and often induced vomiting to obtain relief. He was readmitted to the same hospital where a duodenal tube was passed, and he was fed through this for two weeks with relief. Last May he again began to have distress. Since this time he has adhered strictly to an ulcer diet but has remained only fairly comfortable. Three days before his admission to St. Luke's, his pain became severe, and he noticed a tarry stool for the first time. His stools have remained tarry ever since. He has had considerable pain in his epigastrium, but a feeling of weakness and vertigo has probably disturbed him more. His blood count on admission was: red blood-cells, 2,900,000; hæmoglobin, 58; white blood-cells, 6,000; polymorphonuclears, 80; and lymphocytes, 20. He was transfused and starved for forty-eight hours. As soon as the bleeding stopped he was put on Lenhart's diet. For four days his stools were negative for blood, but they again became positive and tarry and his hæmoglobin dropped from 68 per cent. to 55 per cent. He was then transferred to a surgical service. Operation January 26, 1932, showed an anterior-wall duodenal ulcer and also a hard, indurated posterior-wall duodenal ulcer with a blood-clot in the centre showing definite evidence of recent bleeding. An incision was made one inch above the pylorus; a finger was inserted into the duodenum and two ulcers were palpated; the incision was prolonged into the anterior wall of the duodenum, excising an ellipse including the anterior-wall ulcer and one-half the pyloric sphincter. A posterior-wall ulcer of large size was excised with a cautery and the edges were closed with continuous chromic suture. The cut edges of the duodenum were then sutured to the cut end of the stomach with three rows of chromic, the suture line being at right angles to the long axis of the stomach to prevent constriction. The mucosa was sutured as a separate layer as this is more strictly hemostatic, and in this way it is unnecessary to turn in as much of the edges as it is with ordinary suture. At the end of the operation the new pylorus easily admitted three fingers; a jejunostomy was then done for feeding purposes by the insertion of an 18 French catheter about six inches below the duodenal jejunal juncture. The tube was passed through the omentum and out the lower angle of the incision.

Convalescence was disturbed slightly by post-operative pneumonia, which started on the second post-operative day. His temperature was normal four days later, and his convalescence was most satisfactory from that time. He was given nothing by mouth for forty-eight hours. Then water only was given in small quantities for the next thirteen days. Feeding was started

through his jejunostomy tube twenty-four hours after operation. The feeding consisted of milk, two ounces; alternating with peptonized milk, two ounces, every two hours. This was increased until he was getting five ounces every two hours. He thrived on this diet, and on the fourteenth day small feedings were started by mouth and the feedings through the tube continued. As mouth feedings were well tolerated, the tube was closed for twenty-four hours and then removed. There was no leakage around it. His stools have been negative for blood since operation. His blood count now is red blood-cells, 4,750,000; hæmoglobin, 83. He has gained sixteen pounds in weight.

In the *ANNALS OF SURGERY*, 1930, Judd reported 464 cases treated this way, nine cases of which were operated upon later for failure to relieve symptoms. Three cases only were reoperated upon for gastric retention.

DOCTOR DONOVAN presented a second case, being a man who was first admitted to the Medical Ward at St. Luke's at the age of fifty-five years March 2, 1927, complaining of tarry stools and vomiting blood. He was transfused; no evidence of ulcer could be demonstrated. He was discharged at the end of two weeks. He was readmitted nine and one-half months later for the same complaints, transfused again and explored. An anterior duodenal ulcer was demonstrated which was excised and a pyloroplasty done December 24, 1927. He did fairly well after this and returned to work. Four months later he was readmitted to the Medical Ward with the same symptoms, that is, vomiting blood and tarry stools. He was transfused twice; bleeding continued; a gastrotomy was done but no source of bleeding was found. A biopsy of liver was taken and his appendix removed. His convalescence was uneventful, bleeding stopped and he remained fairly well until November 5, 1931, when he fainted, vomited large amounts of blood and had tarry stools. He was transfused three times and operated upon again December 7, 1931. At this time his blood count was red blood-cells, 3,300,000; hæmoglobin, 66. A posterior duodenal ulcer of large size with indurated walls was found about one inch beyond the pylorus. A posterior Polya resection was done, excising that part of the duodenum including the ulcer. His convalescence was uneventful, and at present he is free from symptoms. His blood count now is red blood-cells, 4,800,000; hæmoglobin, 75. Fluoroscopy March 3, 1932, showed stoma functioning well, stomach emptying rapidly, no spasm, no dilatation of the intestinal part of the anastomosis.

DOCTOR DONOVAN presented a third patient, a man aged forty-four years, who was operated upon in December, 1919, by Doctor Downes, and an anterior-wall duodenal ulcer excised. He remained entirely free from symptoms for the next nine years. Two years ago he began to have some discomfort in the epigastrium, but it was never localized and was relieved by milk or soda. With care about his diet he remained fairly comfortable until last August, when his pains got worse and he was put on a milk diet. He received some relief from this diet when he took it every two hours. His pain was always worse at night, and he vomited regularly about once or twice a week with relief. He continued this régime until December 20, 1931, when he was admitted to St. Luke's because of the severity of his pain. He was kept in bed for three weeks on Lenhart's diet, but he did not feel relieved at the end of this time. An X-ray showed a penetrating duodenal ulcer. He was operated upon January 8, 1932, when anterior- and posterior-wall duodenal ulcers were found, the latter having penetrated the pancreas.

There was considerable acute inflammatory reaction around it. A posterior Polya was done, excising that portion of the duodenum bearing the ulcers. He is now free from symptoms.

Fluoroscopy, March 7, 1932, showed stoma open; stomach emptying rapidly; no dilatation of the intestinal loops and no spasm around the stoma.

BLIND POUCH GROWTH OCCURRING NINE YEARS AFTER PARTIAL COLECTOMY WITH LATERAL ANASTOMOSIS

DR. OTTO C. PICKHARDT presented a young girl who was admitted to Lenox Hill Hospital, February 20, 1923, aged five years. She was shown before the New York Surgical Society, February 23, 1927, as a case of cecal ulcer with lymph-node hyperplasia, simulating sarcoma (four years post-operative) (see *ANNALS OF SURGERY*, vol. lxxxv, No. 6, June, 1927). She underwent two operations in March, 1923. *First*.—Ileocolostomy (transverse colon), with lateral or side-to-side anastomosis. *Second*.—Resection of terminal four inches of ileum, cæcum, ascending colon and three inches (about half) of transverse colon. In other words, the intestine which had been short-circuited in the first operation, due to pathological changes, was removed. The child made a good recovery. She was presented here among other reasons, because:

(1) The extensive large gut resection did not seem to have hindered normal growth.

(2) The small blind pouch, left at the hepatic end of the transverse colon, had practically doubled itself in size. Whether this was because of natural gas distension or because of normal growth in the large intestine, was not clear. The question was asked, "Will this blind pouch continuously increase in size and will it finally cause abdominal symptoms?" Up to now, the answer must be "no."

At that time the relative size of the other blind pouch—the distal end of the small intestine—presented because of the lateral anastomosis, was not taken cognizance of.

This same patient is now presented again, after a five-year interval, to show: that the extensive resection has not hindered her in her normal growth, either physically or mentally. She is now fourteen years old (eight years and eleven months post-operative). In height she is 62.5 inches, the average being 60.3 inches. Her weight is ninety-six pounds, the average is 100.3 pounds. She is therefore two inches taller and four pounds lighter than the average normal girl of her age. She has always been a very active child, both physically and mentally. Her bowels move, either once or twice daily, without medication of any sort. Her wounds have remained firm and well-healed, and no herniæ are present.

The growth in the blind pouches is as follows: (A) *Large intestine*.—This pouch has changed comparatively little in length; measuring now approximately twelve centimetres as compared to nine centimetres five years ago. This would appear as a rather normal amount of natural growth, remembering also that the normal peristaltic wave would tend to empty this pouch.

(B) *Small intestine* (blind pouch).—Here we find a different condition. Approximate measurements show five years ago a length of fourteen centimetres which now has risen to approximately twenty-two centimetres, practically a 50 per cent. increase. In width it has increased from three centimetres to four centimetres. The general impression is that this pouch now, as a whole, is from one-half to two-thirds larger than five years ago, particularly in its distal club-shaped portion. Here the patient has to con-

tend not only with normal growth but also with the hydrostatic pressure of the isoperistaltic-driven fluid fecal content.

In the eight years and eleven months since the first operation, the ratio between these two pouches is at least one to three.

This larger, small intestinal pouch, then, rather than the smaller, large intestinal one, appears as a menace and a potential source of danger, from the standpoint of obstruction, either within itself or to other portions of the intestinal tract.

DR. DEWITT STETTEN remarked that he would give serious consideration to the question of resecting these blind pouches. Some years ago he had the opportunity of observing a case of Doctor Kammerer's in which there was a perforation of such a pouch after a partial exclusion. The operation of resecting these pouches ought not to be difficult and should be devoid of any great risk. He believes that perforation is not an unlikely occurrence, especially where the peristaltic movement is toward the blind end.

DR. ALLEN O. WHIPPLE said that he had occasion to operate a year and a half ago on a patient with a large ileal pouch due to a chronic inflammatory process in the mesenteric glands resulting in shutting off of the ileum. The patient came from Ireland and was found to have had the condition for at least twelve years. The interesting feature was that she had developed evidences of intestinal stasis and typical pellagra. Some twenty-four cases have been reported in which ulcerative conditions of the intestinal tract have been associated with manifestations of pellagra, and that is one possibility that should be considered in these cases.

DOCTOR PICKHARDT, in closing the discussion, referred to the size of the intestine in children and adults. In 1923, John Bryant wrote an article, "Observations upon the Growth and Length of the Human Intestine." From this article Doctor Pickhardt quoted the following observations.

Length of intestines apparently must be correlated to four known factors, *i.e.*, body length, age, sex, and disease.

In the adult, colon length about equals body length, the small intestines being about four times the length of the body.

In the child, the question of sex makes no difference in regard to intestinal length.

Without exception, all male and female children examined, of a body length greater than sixty centimetres, had already acquired a small intestine longer than the minimum length compatible with prolonged adult life. But at this same early period of life, these children had not yet acquired much over half the corresponding length of colon.

Not later than the tenth year of age, practically all the children examined had already acquired both small intestines and colons of lengths such that had they been found in the adult, they would have been classified as within the normal adult limits of intestinal length.

It would appear then, that from the tenth year of age onward, intestinal growth is an affair primarily not of increase in actual length, but of increase in area through increase in calibre.

The child of ten years of age has both a small intestine and a colon of a length considered normal for the adult.

Growth of the intestine after ten years of age is an affair primarily not of growth in length, but of growth in calibre.

In the adult, the male has a small intestine and colon about 6 per cent. longer than the general adult average. In the female, the small intestine is about 5 per cent., and the colon about 10 per cent. shorter than the general adult average.

NEW YORK SURGICAL SOCIETY

The normal average length of the small intestine in the adult may be considered as 6.11 meters or twenty feet six inches. The normal average length of the colon in the adult may be considered as 1.52 meters, or five feet two inches.

ECHINOCOCCUS CYST WITH CALCIFIED ADVENTITIA— COMPLETE REMOVAL

DOCTOR PICKHARDT presented a man, forty years of age, Hungarian, who was admitted to Lenox Hill Hospital, August 7, 1930. Had been in the United States for twenty-six years, with one visit to Europe two years ago. During this visit he developed a fever with indigestion and alternating attacks of severe diarrhoea, and constipation. At present he has a continuation of these symptoms for which dispensary treatment has been unavailing. Loss of weight from 202 pounds to 152 pounds. His abdomen was somewhat full, particularly on the right side. Just below the right costal margin, more toward the mid-line, was a deep, large, rounded mass, projecting from under the liver edge, which could be felt as a hard, smooth, and distinct line. This mass moves with respiration. It is attached to the liver and is not particularly tender. White blood-cells, 9,750; polymorphonuclears, 66 per cent.; eosinophiles, 3 per cent. Echinococcus fixation test—negative. Icteric index—8.0. Van den Bergh—negative. Wassermann—A:O; + C:O.

Röntgenogram.—*Graham test.*—The gall-bladder fills and is seen to be on a level between tenth and eleventh ribs. It is displaced upwards by a rounded mass, apparently arising from the lower and outer border of the liver. The gall-bladder functions well.

Operation.—August 14, 1930, by Doctor Pickhardt:—A Kocher subcostal incision was made on the right side. This exposed a large, grapefruit-sized, hard, round tumor mass, arising in the lower border of the left aspect of the liver, and impinging against the intestines below. The cyst extended backwards into the lumbar region and to the vertebræ. When the adventitia was opened an uncountable number of thin-walled transparent cysts containing fluid and ruptured cysts of various sizes were found. These were scooped out with a large spoon until the cavity was clean. The cavity was then sprayed with ten cubic centimetres of pure formalin which was then wiped out and the same procedure again done with 90 per cent. alcohol. The cavity was then packed with iodoform gauze after the edges of the adventitia have been marsupialized to the skin.

The cysts contained a cloudy, watery fluid whose turbidity was apparently caused by small white particles.

Microscopical sections of the daughter cysts showed healthy scolices of *tænia echinococcus*.

For the first two weeks after the operation there was the usual amount of discharge from the wound, then a foul odor became apparent, and then bile appeared on the tampon. During the next five weeks, the amount of discharge continued the same and in spite of various irrigating solutions the odor became more foul. Occasionally, a few small calcified plaques would come away. The condition as far as healing was concerned had come to a standstill, and the external opening was so contracted that it did not allow proper drainage. The interior of the cavity was lined with gritty, calcium deposits which kept the walls rigid and did not allow obliteration of the cavity.

October 15, 1930, two months and two days after the first operation, the old wound was enlarged at either angle. This exposed a cavity the size of a small grapefruit, lined with a thick connective-tissue sac within which were calcareous deposits, and which was trabeculated and grown into deep folds. No attempt at granulations was present. This adventitia in its

REMOVAL OF ECHINOCOCCUS CYST

superior aspect was pressed tightly against the liver, and inferiorly and laterally against the peritoneal cavity. A line of cleavage was found and then by means of finger dissection, with considerable difficulty, a thick-walled, firm, hard, cup-shaped membrane, the adventitia of the echinococcic cyst removed at the previous operation, was shelled out except for a small portion at the inferior surface near the skin. Here a too dense connection with the peritoneum made it unwise to attempt removal. A moderate amount of bleeding, particularly from the liver surface, was encountered but was controlled by packing. The cavity was then tightly packed with plain dry gauze and the wound left wide open.

Microscopical examination showed the specimen to consist of a mass of hyaline connective tissue in which were numerous areas of necrosis and calcification. Cellular elements were exceptionally scanty.

There was considerable post-operative shock and rise of temperature for the first four days. Much improved by the seventh day. There had been a moderate bile discharge. This day the original tampons were removed with very little bleeding. The inside of the cavity looked quite clean except for the area at the lower surface where a part of the wall had been left in. Some of this tissue was removed and the wound packed loosely with three gauze tampons. At the end of another week a remarkable change for the better was noticed. The size of the cavity had decreased at least a half and there was a moderate, mild, mucoid bile discharge.

November 22, 1930.—Five weeks after operation the wound was practically healed, having granulated from the bottom up. There was no bile discharge. Echinococcus fixation test was negative. Discharged to outpatient department for further dressings.

February 1, 1931.—Wound has remained healed since the last dressing December 26, 1930. No mass. No evidence of hernia. Still complains of gastric symptoms.

February 12, 1932.—Echinococcus fixation test—negative. Wassermann, negative; blood count: white blood-cells, 5,300; polymorphonuclears, 78 per cent.; eosinophiles, 0. Moderate indigestion symptoms. Some pain in wound on change of weather. Wound firm. No hernia. No return of mass. Condition excellent.

The interest in this case lies in the secondary removal of the thick, partially calcified adventitia, without mishap or complication.

REMOVAL OF ECHINOCOCCUS CYST; ITS INFLUENCE ON SPECIFIC BLOOD REACTION

DOCTOR PICKHARDT present a woman, twenty-nine years of age, born in Germany, who was admitted to Lenox Hill Hospital, July 29, 1929, with the history that thirteen years before admission, she noticed the presence of a lump in the epigastrium. It progressively became larger and at the age of twenty-two years (seven years previous), following attacks of pain and vomiting, laparotomy was performed, in Germany, and encapsulated worms (Hundewurmer) were removed. Following this she enjoyed good health up to three months before admission at which time she had attacks of right upper quadrant discomfort and occasional vomiting, with lump formation as previously.

Examination revealed a large, rounded mass in the right upper quadrant, connected with the liver, and moving with respiration. It extended in the mid-line down to the umbilicus and laterally to the right into the mid flank. It was not particularly tender.

The laboratory tests gave Wassermann: A: 3 plus, C: 4 plus; white blood-cells, 8,400; polymorphonuclears, 37 per cent.; eosinophiles, 6 per cent.

A diagnosis of echinococcus cyst of the liver was made but on account of the concomitant lues, it was decided to give the patient intensive anti-specific treatment, pre-operatively. This was done for three months but instead of a decrease in the size of the abdominal mass, it increased, and the Wassermann remained at A: 1 to 2 plus, C: 1 to 2 plus.

The patient was readmitted to the hospital November 20, 1929, for operation.

November 27, 1929, Doctor Pickhardt made a four-inch upper right rectus incision. Because of a previous operation and because of numerous adhesions, it was impossible to enter the peritoneal cavity. A two-way trocar was then inserted into the most prominent portion of the swelling. Immediately a perfectly clear, slightly yellowish fluid, containing a few whitish granules (scolices) exuded under pressure. In this manner, 700 cubic centimetres of fluid were collected in a sterile container; ten cubic centimetres of pure formalin were then instilled into the cavity and allowed to remain for five minutes.

With the trocar in place as a guide, a two-inch vertical incision was made into the cyst outer wall, or adventitia. Within this cavity there was found the real echinococcus cyst which was whitish in color, quite friable and only moderately adherent. By means of strong suction this was completely removed in about three pieces.

Following this, the interior of the adventitia was swabbed out with 90 per cent. alcohol. The cavity was rather lobulated, of a dirty whitish-green character and the thickness of the adventitia at least three millimetres. This cavity was covered superficially by a layer of liver tissue about five to six millimetres in thickness, was in the right lobe of the liver and extended down into the right flank, and was completely walled off from the peritoneal cavity proper. It was lateral to the gall-bladder, the tip of which could be seen indistinctly completely surrounded by adhesions. No daughter cyst of any size was recognizable.

After thorough cleansing of this cavity with saline and suction, two or three times, it was again filled with saline solution by means of a funnel and then the cavity was tightly closed with interrupted chromic sutures. No marsupialization was done. A rubber tube was placed down to the suture line in the cavity and the abdominal wall closed around it.

The post-operative course was uneventful. Very moderate rise in temperature, with slight cough. No definite signs of anaphylaxis as shown by urticaria. There were some indefinite signs of bronchial spasms but not of great moment.

Nineteen days after operation, the patient was discharged in excellent physical and mental condition. Wound is completely closed and well healed.

February 7, 1932.—Echinococcus fixation test, negative. Wassermann, A: plus minus, C: 1 plus. Blood count, white blood-cells, 3,600; polymorphonuclears, 68 per cent.; eosinophiles, 1 per cent. No symptoms, feels well, gaining weight, now up to 156 pounds; no mass.

The points of interest in this patient are: (1) ease of removal of cyst. (2) Closure of wound, without deep drainage. (3) Consistently negative complement fixation test, both pre- and post-operatively, except for one report. (4) A strongly persistent positive Wassermann in spite of intensive antisppecific treatment pre-operatively, *but* immediately post-operatively, a drop to negative or at most one plus Wassermann reports, without any further treatments.

Among the various conditions which may cause a positive Wassermann, there is no mention of echinococcus disease.

REPAIR OF INJURED COMMON BILE-DUCT

DOCTOR LEWISOHN referred to a patient whom he had presented before this Society about two years ago after transpleural drainage of an echinococcus cyst of the liver. Nine months ago he removed the cyst by an abdominal route. The patient was seen that afternoon. He is apparently cured.

REPAIR OF INJURED COMMON BILE-DUCT

DR. THOMAS H. RUSSELL presented a woman, forty-two years of age, whom he first saw January 30, 1931. She had been operated upon two days before for chronic adhesive cholecystitis and appendicitis. The gall-bladder and appendix were removed. At this time she was nauseated, the abdomen was moderately distended, her temperature was 101° , pulse 100, and there was a moderate degree of jaundice which was more marked in the sclera. The urine was port-wine color. The blood icterus index was 55.

In view of the possibility of an injury to the common bile-duct he opened that afternoon the wound in the upper abdomen which was done by simply removing all sutures of the abdominal wall. The common duct was easily found and the first ligature which he saw, having fortunately been cut long, was found encircling the common bile-duct just above the point of junction of the cystic duct. There was also a ligature around the cystic duct just distal to the point where it had been cut in the performance of the cholecystectomy. The common bile-duct was gangrenous about the ligature encircling it. The ligature was removed and after making a longitudinal incision in the duct a "T" tube was inserted. A cigarette drain was placed down to the foramen of Winslow and the wound closed in layers with plain catgut. The skin with silk.

The patient made an uneventful recovery. The icteric index was 30 the next day, and 17 two days later. On the twenty-first post-operative day the "T" tube slipped out, and bile drained from the abdominal wound.

The patient insisted upon going home on February 28, four weeks from the day of the second operation.

Four days later, March 4, 1931, she was admitted to St. Francis Hospital stating that the wound continued to discharge large quantities of bile, and that she was troubled with much abdominal distress after meals. Her stools are formed and of natural color. After a few days' rest in the hospital she felt better, until, March 16, there appeared to be slight jaundice. The icteric index was eleven. In a few days the jaundice disappeared and she felt well again. March 31 she was decidedly jaundiced and icteric index was 40.

April 4 the abdomen was reopened by incising the old scar in the upper abdomen and the common duct exposed. A stenosis of the duct for about one inch in length was found at the site of the old trouble. This stenotic part of the duct was excised and an effort was made to bring the two ends of the duct together over a "T" tube. As about one inch of the duct had to be removed at this operation he was unable to get accurate apposition of the ends, hence the chances of a recurrence of the stricture at this site were probable.

As reports of various operations designed to establish a fistula to later anastomose into the stomach have heretofore been unsatisfactory in a large percentage of cases the reporter attempted to try a different procedure which consisted of bringing the long piece of the "T" tube up along the posterior wall of the stomach just proximal to the pylorus, sewing a piece of the gastrohepatic omentum about the tube so as to fix it to the stomach wall with the idea of having a sinus to form along the stomach wall to

later open into the stomach. This was accomplished very easily. The abdominal wound was again closed around the tube and a cigarette drain.

The cigarette drain was removed on the third post-operative day. Bile drained from the abdomen around the "T" tube for several days then ceased. In a few days the "T" tube was pinched off with a Murphy drip clamp for several hours a day until finally the patient was taught to unpinch the clamp for a few minutes night and morning, and to keep the tube in position by means of adhesive-plaster strips.

The patient was discharged from the hospital May 2, 1931. She returned every few weeks for examination until October 20, 1931, when she was readmitted for the final operation. She had gained in weight and stated she felt well and had been doing her usual household duties.

October 23, 1931, icteric index was 10. October 26 the sinus around the tube was dissected free down to where the tube was fastened to the posterior wall of the stomach. A two-inch incision was made through the anterior wall of the pyloric end of the stomach parallel to its long axis, then a stab wound made through the posterior wall of the stomach into the sinus containing the tube. Several inches of the long end of the tube were cut off and the tube pulled through into the stomach.

The tube was then cut off flush with the inner surface of the stomach, but was not removed as the tube had been retained with so much difficulty that it was thought it would soon be discharged into the stomach. The anterior wall of the stomach was closed transverse to its long axis to avoid narrowing of the stomach at this point. The excess sinus was cut off and end sutured. The abdomen was closed without a drain. The patient made an uneventful recovery. November 4, 1931, a flat X-ray of the abdomen showed the tube still in position.

The patient left the hospital November 14 and has returned monthly for X-ray. The last one, taken February 2, showed the tube still in position. She is now feeling well and doing her regular work.

All the above operations were done with spinal anaesthesia, using two cubic centimetres of spinocaine.

DR. DEWITT STETTEN said that in 1914 he had a similar accident in an apparently simple cholecystectomy. The patient was a woman, at that time sixty-four years old, who had a somewhat thickened gall-bladder, containing a solitary ovoid calculus and with a fistulous communication between its fundus and the duodenum. After separating the adhesion between the fundus of the gall-bladder and the duodenum and closing the opening in the duodenum, he proceeded in the usual manner to perform a cholecystectomy, which was by no means especially difficult. After ligating and dividing the mesentery of the gall-bladder, he noticed a rather larger lumen than usual, and, removing the ligature, he found that he had completely divided the hepatic duct transversely. He attributed this accident to an anomaly that is not unusual—namely, a parallelism of the cystic and hepatic ducts. Under these conditions a division of the hepatic duct can very easily occur. Fortunately, Doctor Stetten recognized the nature of the mishap and was able to perform without much trouble an end-to-end anastomosis of the divided duct. The patient made a relatively uneventful convalescence with only slight biliary drainage for a short time. Thirteen years later, in 1927, when the patient

POST-PYLORIC ULCER UNDER THERAPEUTIC MANAGEMENT

was seventy-seven years old, Doctor Stetten saw her again. At that time she was complaining of what appeared to be a mild attack of cholangitis with slight jaundice and elevation of temperature. She recovered from this under medical treatment and, as far as Doctor Stetten knows, she is still alive and well.

DR. J. WILLIAM HINTON said that in reference to a short fistulous tract, he reported a case a few years ago of a woman who had complete obstruction. Direct anastomosis of the common duct to the stomach was done. This was an easy operation to do and the patient made an uneventful convalescence and was shown here seven months after operation. In one year she came back with itching of the skin and was treated in the hospital with biliary drainage. The woman died suddenly from embolus.

DR. SEWARD ERDMAN thought that the method described by Doctor Russell, like all operations which depend on the formation of a connective-tissue tract about a rubber tube, entailed the later probability of scar-tissue contraction. It would be more nearly ideal if the stump of the duct could be implanted directly into the stomach.

DR. PERCY KLINGENSTEIN said he believed that whenever possible direct end-to-end anastomosis is the method of choice in dealing with common-duct injuries. He had particularly in mind a patient in whom the common duct had been divided during manipulation incident to the evacuation of many stones in the choledochus, and direct anastomosis over a tube had been done. About a year later reoperation was required for recurrent symptoms of jaundice, chills and fever and the two previously approximated ends were found to be disunited with the common duct full of detritus. The ends were again sutured posteriorly and tube drainage effected. Since that time the patient has been symptom-free except for occasional attacks of pain.

DOCTOR RUSSELL, in closing the discussion, said that he once had an accident similar to that mentioned by Doctor Stetten but he did an end-to-end anastomosis over a tube and at the end of three months the woman passed the tube and has since remained perfectly well.

POST-PYLORIC ULCER UNDER THERAPEUTIC MANAGEMENT OF INTERNIST, RADIOLOGIST AND SURGEON

DR. FREDERIC W. BANCROFT read a paper with the above title for which see ANNALS, December, 1932, p. 1036.

DR. HENRY W. CAVE asked Doctor Bancroft how long medical therapy is carried out before failure is admitted. He thought that to take too authoritatively the advice of the röntgenologist is a bad thing. More frequently than not a careful history of the patient and physical examination will mean as much, if not more, than X-ray interpretation. Having the röntgenologist check up with the findings at operation and injecting the specimen with barium is instructive. Doctor Cave expressed his surprise that Doctor Ban-

croft removed the appendix on X-ray findings alone. But his 82 per cent. benefits may justify the procedure; he did not agree with Doctor Bancroft's removal of the appendix where there were no subjective or objective symptoms. Doctor Bancroft's operation is a choice one in that it puts the ulcer in an alkaline medium and gives a satisfactory closure of the pylorus, and has not the difficulties of attempting excision of the ulcer particularly when it is attached to the pancreas. He did only one gastroenterostomy! Surely gastroenterostomy still has its place in surgery of the duodenal ulcer, particularly in those ulcers of long standing with a large excess of hydrochloric acid and marked deformity of the cap producing obstruction. The Levine tube has often proved a life-saving measure; many secondary operations have been prevented by its use. The most important part of this team work is the assistance of the internist in establishing a long, careful, pre-operative preparation of the patient, his daily post-operative round and meticulous post-operative supervision.

DR. CHARLES W. LESTER (by invitation) said that operations on the appendix for the prophylaxis or treatment of post-pyloric ulcer are undertaken for the purpose of correcting pylorospasm. Pylorospasm is a persistent contraction of the pyloric muscle during a large part of each gastric cycle. The pyloric muscle is fan-shaped and embraces the pyloric region. During gastric peristalsis it is relaxed until the peristaltic wave reaches it. Then it contracts on the gastric contents in its embrace and forcibly squirts it into the duodenum. Thus it is not a true sphincter although it can have a sphincteric action. Its nerve supply is by a separate branch of the sympathetic.

Irritation anywhere in the peritoneal cavity can set up impulses along this sympathetic route which bring about a spasmodic contraction of the pyloric muscle and make the condition known as pylorospasm. The most frequent site of this irritation is in the region of the appendix. The appendix is usually found kinked by adhesions and these adhesions frequently involve the cæcum, terminal ileum and sometimes the ascending colon. Simple appendectomy in the presence of these adhesions will not suffice to remove the irritation. The adjacent gut must also be freed. Nor will all cases of pylorospasm be benefited by appendectomy. The cases must be selected with care on the basis of clinical and röntgenological evidence of trouble in the right lower quadrant. All the successful cases cited by Doctor Bancroft had this evidence which was verified by the operative findings. It is futile to remove the appendix when the source of irritation lies elsewhere in the peritoneal cavity.

DR. RICHARD LEWISOHN agreed with Doctor Bancroft as to the importance of a close coöperation between the internist, the radiologist and the surgeon. However, he thought that to put the question of operative indication on the radiological department meant a very heavy burden for the radiologist. While his opinion should carry a great deal of weight, the final decision must rest in the hands of the clinicians.

POST-PYLORIC ULCER UNDER THERAPEUTIC MANAGEMENT

Doctor Bancroft stated that he had performed an appendectomy in eleven cases of duodenal ulcer without subjective or objective signs of appendicitis, purely on X-ray findings. The appendix was removed through a McBurney incision. Stomach and duodenum were not inspected or palpated. Doctor Lewisohn wondered whether any definite conclusions could be drawn from this series of cases. When a cure was effected, the possibility of an erroneous X-ray diagnosis would have to be considered. It would be reasonable to assume that the patient did not suffer from a duodenal ulcer, but from chronic appendicitis. Pylorospasm due to a diseased appendix is undoubtedly a very rare occurrence. It would require an observation time of at least five years to exclude the possibility that we were not dealing with a temporary improvement due to an intermission-period in the life cycle of a duodenal ulcer.

Doctor Bancroft has reported on twenty-one major gastric operations (two Billroth I, two Billroth II and seventeen Devine operations).

Doctor Lewisohn stated that he had no personal experience with Devine's gastric exclusion. The latter procedure does not differ considerably from Eiselsberg's "Exclusion zur Ausschaltung." In both operations the duodenal ulcer is left *in situ* and the acid figures are not reduced materially. Eiselsberg does not use his method any longer, as the incidence of recurrent gastrojejunal ulcers was very high. The late follow-up results following the Devine operation are not apt to be better than those following the Eiselsberg method. A simple side-tracking operation with resection of part of the stomach (Eiselsberg, Devine) rather than a Billroth I or II with removal of the ulcer, should never be the method of choice in gastroduodenal surgery. Even Finsterer's Resection zur Ausschaltung, which establishes a marked reduction in acidity, should be used only in non-resectable duodenal ulcers.

Doctor Bancroft reported an average of between 50 and 60 per cent. cures with different surgical procedures in the presence of a duodenal ulcer. These statistics, even in a follow-up of short duration, are not superior to those which had been reported by Doctor Lewisohn following gastroenterostomy. Furthermore, it is very possible that some of the cures are temporary and will not stand the test of a five-year follow-up (the usual minimum requirement as to end-results).

DR. FRANK S. MATHEWS said that he finds in this paper a number of viewpoints with which he cannot concur. It seems to him that the operating surgeon assumes a responsibility to a patient which he cannot delegate to members of a committee even though it is advisable for him to seek advice wherever he can get it. If Doctor Bancroft should operate on a patient with duodenal ulcer and explain afterward to the patient that the operation had been dictated by a physician and a radiologist on the basis of a previous agreement, neither in law nor morals could his position be defended. Surgery is a dignified profession and the patient can hold the surgeon directly responsible for the selection of operation and the type of operation per-

formed. Most surgeons become a little touchy if they find that their patients consider them at all as expert mechanics to be directed by some wise physician. In the cases reported a number of operative procedures have been employed, nearly all of which are operations of a greater magnitude than gastroenterostomy. Here Doctor Mathews seemed to see the influence on Doctor Bancroft's work of a radiologist who has been so outspoken in his condemnation of that operation. Doctor Mathews is perfectly convinced that gastroenterostomy is a valuable surgical operation. In 1931, Balfour and associates operated on 450 patients with duodenal ulcer and performed gastroenterostomy on 58 per cent. with less than 1 per cent. mortality. In 32 per cent. the ulcer was excised with a plastic on the pylorus. This leaves but 10 per cent. of the cases for resections and exclusions. Every month at his follow-up at St. Luke's Hospital Doctor Mathews has been impressed by the good results of gastroenterostomy in selected cases, as the patients come back year after year with scarcely any complaints. The results, he is confident, are due to the gastroenterostomy, although the radiologist referred to has asserted that ulcers heal in spite of it. Doctor Mathews sees no reason to replace the operation by more formidable ones in the average ulcer case requiring operation. He has done exclusions and resections in duodenal ulcer, but is strongly impressed with the extensive field of usefulness of gastroenterostomy in these cases. He believes the abolition of this operation from Doctor Bancroft's series further indicates that he has been ill-advised in sharing the responsibility for the selection with others who are not operating surgeons.

DR. J. WILLIAM HINTON said that in the Stomach Clinic at Bellevue Hospital they have had 460 cases in the past four years. Of that number 128 were post-operative cases. Of the 128 cases 59 per cent. have been operated on for acute and 69 per cent. for chronic ulcer. That leaves 332 unoperated cases of ulcer seen in that time. Of the 69 per cent. operated there are twelve with marginal ulcer, 16 per cent. of gastrojejunal ulcer, three of whom the speaker personally operated on. He had been very much surprised at these figures which convinced him that gastroenterostomy is not as ideal a procedure as he had thought it. Patients have come back seven years after gastroenterostomy. They felt fine at first but developed pain from jejunal ulcer. It has been proven by gastroenterological studies that many of the patients have been treated medically for years afterward. As to the follow-up, Doctor Hinton did not believe this was of any value unless the patients are seen personally.

DOCTOR BANCROFT, in closing the discussion, said that he had expected there would be some criticism of the policy adopted. Nevertheless, he had felt that it was worth an experiment to attempt to improve the treatment of duodenal ulcer. If a marked advance could be made by a similar method in the treatment of diabetes, it could be achieved in ulcer. Therefore, as an experiment, it had been decided that the surgical department would, on the

LATERAL DISLOCATION OF THE KNEE-JOINT

recommendation of the internist, remove the appendix in cases of early ulcer or pylorospasm, without exploring the ulcer. He felt that the results had justified the experiment. The fact that a large percentage of the ulcer cases were free from symptoms on an unrestricted diet, and that there was only an 18 per cent. failure, he felt, justified the experiment. In pylorospasm the results, of course, had been better than in ulcer, as shown by the figures. The discussion of whether the internist and radiologist should dictate the policy in reality did not work out as didactically as one might assume from the plain statement. As a rule, in the discussions of the cases, it transpired that all three agreed on a given policy. This was largely due to the fact that the surgical department had no desire to operate on a large series of duodenal ulcers, but only to operate on the cases with a prolonged history and which were obvious medical failures.

The speaker did not agree with Doctor Lewisohn that subtotal gastrectomy is the operation of choice in the hands of the general surgeon. He felt that the mortality would be so great that the operation would not be justified. He also felt that in cases with a prolonged history and deep scarring a gastro-enterostomy has too many failures to justify its use.

Doctor Bancroft realizes that the series of cases presented is small and that a sufficient length of time for follow-up analysis has not elapsed to draw didactic conclusions. So far, however, the post-operative results of the Devine operation have been satisfactory.

STATED MEETING HELD APRIL 13, 1932

The President, DR. JOHN DOUGLAS, in the Chair

LATERAL DISLOCATION OF THE KNEE-JOINT

DR. JOHN H. GARLOCK presented a man, forty-two years of age, who was admitted to the Second Surgical Division of the New York Hospital, November 8, 1930, with a history that a few minutes before, his right leg was caught between an elevator and the elevator shaft, and the knee severely twisted.

Examination showed there was a complete lateral dislocation of the knee-joint. (Fig. 1.) The lower end of the femur was displaced internally and the articulating surface could be felt beneath the skin. The upper end of the tibia was displaced externally, and its superior articulating surface could be easily palpated.

The patient was anæsthetized and the dislocation was reduced by a combination of traction, hyperextension, and counter-pressure on the tibia and femur in opposite directions. A posterior splint was applied. Active motion was instituted on the fifth post-operative day. At this time, 20° flexion in the knee-joint was already present. Active motion was then continued three times daily for a period of ten minutes. He was allowed out of bed on crutches on the twenty-third post-operative day. Physiotherapy was then instituted. A brace was obtained for him which he wore for a short while. It was felt that this support was indicated because of undoubted injury to the crucial ligaments.

His condition at the present time is as follows:

Extension is normal. Flexion proceeds through an arc of about 110° . There is no instability of the knee-joint in any direction. The patient gets about without the aid of any support, and there is no appreciable limp. He was presented because of the rarity of the injury and to call attention to the



FIG. 1.—Lateral dislocation of knee.

complete lack of instability in the knee-joint even after the severe trauma, which undoubtedly involved tearing of the crucial ligaments.

DR. JAMES M. HITZROT said that there are a number of operations that have been devised for the repair of tears of the crucial ligaments, but their

FRACTURE AT LOWER END OF TIBIA

desirability as well as the results obtained are still under discussion. In Doctor Hitzrot's experience, by simple fixation stable knee-joints are obtained after dislocations in spite of the fact that the ligaments may be completely torn. In fractures in which the ligaments are involved, the coincident injury to one or the other of the intra-articular cartilages is the serious complicating factor.

DR. BRADLEY L. COLEY said that he had recently under his care a man with a lateral dislocation of the knee-joint. The leg was displaced laterally and there was complete tear of the internal lateral ligament. It was apparent from a study of the X-ray films that the crucial ligaments had been torn. The patient was brought to the hospital within an hour of the accident and the knee was immediately reduced and placed in plaster. The plaster was kept in place for four weeks and then removed. At this time there was no abnormal mobility of the knee in any direction. The man was able to walk and his convalescence continued satisfactorily. He is now back at work ten weeks from the date of the accident.

FRACTURE AT THE LOWER END OF THE TIBIA WITH MARKED DISPLACEMENT

TWO OPEN OPERATIONS. RESULT AFTER TWO AND A HALF YEARS

DOCTOR GARLOCK presented a man, fifty years of age, who, in September, 1929, was first seen nine weeks after he fractured his right ankle. After the accident, he was taken to a hospital in New York, where, without anæsthesia, a plaster case was applied. After two weeks he returned home.

Examination November 27, 1929, showed a marked deformity just above the right ankle due to a badly comminuted fracture of the lower end of the tibia with marked displacement of the fragments. Clinically, there was no evidence of union. December 2, 1929, the site of injury was exposed by a curved incision on the antero-medial aspect of the lower leg. There was no evidence of union. The distal fragment was markedly comminuted, but presented one large fragment anteriorly. The upper fragment was displaced inward and backward. The ankle-joint was visible in the field. At this time nothing was done to the fracture of the shaft of the fibula. The fragments were mobilized, and what was thought to be a satisfactory reduction was accomplished. A sliding bone inlay graft taken from the upper fragment was then placed across the line of fracture. The wound was closed after careful hemostasis and a circular plaster case applied from toes to mid-thigh. Post-operative X-ray examination revealed that a complete reduction had not been accomplished, and that a serviceable weight-bearing surface had not been produced. Therefore, a second operation was performed December 26, 1929. An external lateral incision was made over the site of the fracture of the fibula. Firm union was found at this point. The fracture was reproduced with a chisel and a mortise fashioned so as to obtain locking of the fragments. This was further reënforced by a kangaroo suture passed through drill holes. The scar of the first operation was excised and the fracture of the tibia again exposed. The bone graft was found firmly united. It was pried loose and preserved. All the tibial fragments were dissected free from the surrounding tissues and mobilized. Reduction was then easily accomplished, but difficult to maintain. It was found necessary to remove the

upper projection of the lower posterior fragment. The fracture was then reduced and the foot placed in inversion. The bone graft was placed in its original bed and the wound closed without drainage. A circular plaster case was then applied from toes to mid-thigh with the foot in inversion and dorsiflexion. The patient was discharged from the hospital January 7, 1930, after an uneventful convalescence. The plaster case was removed after two and one-half months and union was found to be firm. He received careful physiotherapy for three months, and began to bear weight on the extremity after four months. At the present time, there is about 30 to 40 per cent. impairment of motion in the ankle-joint. The patient has a good weight-bearing surface, and is able to carry on his activities without difficulty.

DOCTOR HITZROT said that in treating these old fractures of the ankle-joint the liberation of both fragments is most important. He had shown before this society (*ANNALS OF SURGERY*, March, 1932) a case in which there was a fracture of the fibula with a posterior fragment broken off from the tibia and displaced posteriorly. The case was ten months old when he first saw it. After liberating both fragments, fibular and tibial, the dislocation of the foot was reduced, but in so doing the circulation of the foot was arrested and that procedure had to be given up. So he devised an operation by which he resected the lower end of the tibia, reconstructing the joint to bring it into the weight-bearing area. Four months after the operation the patient was able to walk on the foot and is now able to do almost anything with that foot, although he has some limitation of dorsal flexion. In another case, operated on previously by another surgeon who made two incisions, Doctor Hitzrot operated two years later because the woman was unable to walk on the foot without a special shoe. After the operation, she could wear a normal shoe. Unless all the fragments are liberated they cannot be gotten back into position. In the first case reported even this was unsuccessful but the operation devised at that time seems, after the lapse of four years, to have been successful.

NON-SPECIFIC GRANULOMA OF ILEUM. ILEOCECAL RESECTION. RESULT NINE YEARS AFTER OPERATION

DR. DONALD GORDON presented a woman, forty-nine years of age, who was admitted to Roosevelt Hospital April 19, 1923, for pain in the right side of the abdomen. She was fairly well until three years ago, when irregular attacks of pain in right side of the abdomen began. During one of these attacks she was operated upon for appendicitis. At the operation, the appendix was found to be normal, but it was removed, and at that time a thickening of the ileum and cæcum was noted, but on account of her condition, resection was considered too dangerous. She was better for a time after the operation, but gradually developed the old discomfort, which continued to grow worse until one and one-half years ago, when, after an acute attack of pain in the right lower quadrant, a mass remained in the right lower quadrant. This mass is very tender, and requires her to support it when she turns over in bed, and to protect it in every way. She has cut down on all food, until she is now taking only toast, tea, and milk. She has frequent attacks of nausea and occasional vomiting. Bowels move two to three times a day with Squibb's paraffin oil. Bowel movements of a diarrhoeal

NON-SPECIFIC GRANULOMA OF ILEUM

character, frequent, profuse, watery, no visible blood, and no tenesmus. She has lost sleep, weight, and strength on account of pain and lack of food. She is growing worse. Her abdomen is scaphoid except at right lower quadrant, where there is a pronounced palpable rounded mass size of an orange in right iliac fossa, slightly movable, hard, and tender at upper end beneath old appendix scar. Operated upon April 20, 1923. Right Kammerer incision eight inches long exposed a large mass in right iliac fossa attached to right side of parietal peritoneum, with great omentum adherent to mass. The ascending colon was angulated back on itself and attached to this mass, bringing the right end of transverse colon down to this position, forming a kink in ascending colon besides the obstruction at the ileocecal junction. The ileocecal mass was released with incision along right lumbar gutter and into mesentery of ileum. This was mobilized, side-to-side anastomosis isoperistaltic was done with linen for outer suture, and chromic catgut for inner suture. The ends had been crushed with clamp, cauterized, and inverted with purse-string of linen. The mesentery was ligated with plain catgut, and the peritoneal denudation covered with few plain catgut sutures. Peritoneum closed with No. 2 plain; rectus sutured with interrupted chromic catgut; skin with interrupted silkworm gut.

Post-operative Course.—Temperature rose to 102° on fourth day, then fell to the normal. Wound drain removed on eighth day. On the thirteenth day temperature started to rise and reached 103.6° . Coincident with temperature there was a marked and rather intractable diarrhoea, which was thought to be the cause of the temperature; but a mass developed in the right side of abdomen, which explained the temperature.

May 18, under local anæsthesia, the old incision was reopened down through the muscles, and a mass found to the right of intestines. This mass was above the old drainage. It was incised and about six ounces of creamy pus evacuated together with remnant of old fibrin of hematoma. Wound drained with three tubes for ten days. Irrigated daily.

After the evacuation of this secondary abscess, the temperature fell immediately to the normal, and remained so. The patient was discharged May 29 with granulating wound with small sinus from which there was a slight discharge. Weight, eighty-three pounds, feeling well, and eating everything.

Subsequent History.—Weight went up to 126 pounds and stayed there until a severe nervous strain one year ago resulted in loss of appetite and weight. Her weight went down to 105 pounds, at which point it has remained for a year. For one year after operation, she had seven to eight bowel movements a day. These gradually became less, and ceased upon changing from seven to eight glasses of water a day to a similar amount of milk.

Examination in March, 1932, shows a moderate hernia for which she does not wear any support. No masses, no tenderness. Patient is very active and has no complaints.

Pathological Report.—*Macroscopical.*—About two feet of intestine of which ten inches is small intestine and rest is large intestine covered with fibrous adhesions and raw edges. There is a tumor mass, seven by five by four centimetres, at the ileocecal junction which is bound down by surrounding adhesions and gives the appearance of beginning intussusception. The centre of the hardened specimen showed a lumen which would just accept a silver probe. The macroscopical slide shows increase of fibroblastic tissue with dilatation of blood-vessels. Few polymorphonuclears, many lymphocytes, and a moderate number of endothelial cells. No giant cells or true tubercles seen.

Diagnosis.—Chronic inflammation of ileocecal region with chronic intestinal obstruction.

DR. JOHN M. HANFORD cited a similar case. The patient was a cardiac, a woman, about thirty years of age, but had compensation. She came to the hospital with acute ileus. At operation a large fusiform mass was found in the terminal ileum. This was resected and it was possible to make an end-to-end anastomosis very near the cæcum. Jejunostomy was done and the patient recovered. She still has attacks of abdominal cramp-like pain but on account of the bad cardiac condition no further operation has been advised.

The specimen removed showed thickening of the gut wall, narrowing of the lumen and ulceration of the mucosa. *Microscopically*.—The main findings were replacement of mucous membrane by granulation tissue, dense infiltration with mononuclear cells and tremendous dilatation of the lymph sinuses in the adjacent mesenteric lymph-nodes. Dr. A. P. Stout, the surgical pathologist, stated that it was an "entirely unexplained ulcerative lesion of the ileum."

DR. CHARLES L. JANSSEN referred to a similar case. The patient was a young woman, twenty-one years of age, who had symptoms of acute appendicitis. Before coming to the hospital she had been ill about fourteen days with elevation of temperature and a mass in the right lower quadrant. Immediate operation was done and the cæcum and terminal ileum were found to be matted together. The appendix was removed with great difficulty on account of the thickening. The patient had a stormy convalescence and three days afterward developed a fecal fistula. Pathological examination showed a marked thickening of the wall of the appendix but no tubercles. That fecal fistula had developed raised the question of tuberculosis but examinations of the chest were negative. Examination of the cæcum showed some deformity. An attempt was made to close the fistula with a direct attempt on the cæcum. Two holes were found, and it was concluded that the fistula was the result of the breaking down of the cæcum through some inflammatory reaction. The patient leaked some fecal material after the operation and from time to time there has been some fecal discharge. As tuberculosis was ruled out it was thought a granuloma should be considered as a possible cause.

DR. CARL EGGERS said that he had operated on two patients who are difficult to classify and who probably belong to the group of non-specific granuloma of the intestines. Both presented large palpable tumors in the right lower abdomen which disappeared completely after an ileocolostomy followed by X-ray treatment.

The first patient, C. T., fifty-seven years of age, came under observation October 14, 1919, with symptoms suggestive of incomplete intestinal obstruction. An X-ray examination was not made at that time. Under medical treatment the symptoms improved and he was not seen again for several months. In February, 1920, he again complained of abdominal cramps and pain over the right lower quadrant associated with constipation and later diarrhoea. There was no vomiting and no blood was noted in the stool. There were no urinary symptoms. Röntgen-ray examination did not help in definitely establishing a diagnosis. The patient was anæmic and had lost weight. Abdominal examination showed a large, nodular tumor on the right side, tender to touch.

Operation, February 19, 1920.—Five-inch right rectus incision. No free fluid. A large tumor presented which fixed the cæcum and the ascending

NON-SPECIFIC GRANULOMA OF ILEUM

colon in their position and extensively invaded the retroperitoneal lymph-nodes as well as the mesentery of the ileum. Whether the tumor arose in the wall of the gut with secondary lymph-node involvement, or whether it was a lymph-node tumor encroaching on the gut could not be determined. It impressed as an inoperable malignant tumor. An ileocolostomy was done after dividing the small gut about five inches from the ileocecal valve. The abdomen was closed without drainage.

The convalescence was uneventful. The wound healed by primary union, and all intestinal symptoms were relieved. He was given a series of X-ray treatments and after a short time the tumor mass disappeared entirely.

About two and a half years later a complete gastro-intestinal X-ray examination was made after a meal and a barium clysma. There was no sign of a tumor or a defect. The ileocolostomy functioned well.

Since then the patient has shown no symptoms in reference to his intestines.

The second case, H. F., sixty-four years of age, was admitted to the Lenox Hill Hospital, May 12, 1931, complaining of pain in the right lower abdomen for about a week. He was markedly constipated but had no symptoms of obstruction. He gave an interesting history of an attack of acute appendicitis thirty-five years before which had recurred about ten times and each time subsided with rest and the application of an ice-bag. Blood in the stools had been noted repeatedly. He had lost fifteen pounds in weight during the last year and during this period constipation had become more pronounced.

For a long time he had been an invalid; he had chronic myocarditis and about a year before admission had developed paralysis of the left arm and the left side of the face. He had a blood-pressure of 240 at that time. At present he was under constant medical care for his cardiac condition and blood-pressure of 200.

The local findings were as follows: Abdomen large, soft, and tympanitic. In the right lower quadrant of the abdomen a large, nodular mass, the size of a grapefruit, was palpable and tender to touch. It filled the iliac fossa and extended upward to two fingers above the umbilicus, mesially almost to the median line, downward to Poupart's ligament, and laterally to about two fingers beyond the anterior superior spine. The tumor was fixed in position but the abdominal wall was not adherent to it. There were apparently no obstructive symptoms or signs. The inguinal lymph-nodes were not enlarged, and no Virchow glands were palpable. He had several lipomata in the abdominal wall. The patient had a bilateral inguinal hernia and a right-sided hydrocele without any suspicion of malignancy. Rectal examination showed hæmorrhoids and a large soft prostate.

The general impression of the patient was quite good. The nature of the growth was doubtful. It was apparently a primary tumor originating in the right lower quadrant.

May 18, 1931, a five-inch right rectus incision was made. A large tumor was found to occupy the right iliac fossa, which extended down into the pelvis, displacing the iliac vessels. It was very large and immobile. It involved and projected into the cæcum and absolutely fixed that part of the gut, and it likewise involved the appendix, the lower ileum, and its mesentery. There was such extensive involvement of the lymph-nodes that it was impossible to say whether the growth originated in the gut with secondary lymph-node involvement or whether it was possibly a primary lymph-node tumor invading the cæcum. It felt somewhat cystic and gave rise to the impression that it might be a large mucocele starting from the appendix, or possibly a gelatinous

carcinoma. A biopsy could not be done without infecting the peritoneum. On account of its size and extensive attachments a radical operation seemed impossible, especially in view of the patient's cardiac condition. A decision was reached to do an ileocolostomy, to give the patient X-ray treatment, and later to attempt removal of the tumor if the condition warranted it.

The ileum was therefore divided about four inches from the ileocecal valve. Both ends were closed and the upper one then united to the middle of the transverse colon by a lateral anastomosis.

The convalescence was uneventful. The wound healed by primary union. A series of six X-ray treatments was given from June 4, 1931, to June 13, 1931. A second operation was then decided on for the purpose of removing the tumor.

June 17, 1931 (one month after the original procedure), under spinal anæsthesia, the old incision was reopened and extended downward for better exposure. Extensive adhesions were encountered and after they were separated it was found that the large tumor mass had almost completely disappeared. All that remained was a small infiltrated tumor mass plastered against the lateral pelvic wall. The landmarks were ill defined. The lymph-node tumor had also practically disappeared. A resection was considered unwise as they were apparently dealing either with an inflammatory lesion, a granuloma of some form, or a very radio-sensitive border-line tumor.

The ascending colon and cæcum were found to be in a state of collapse. There was apparently no regurgitation of fæces into this excluded loop of gut and there was therefore no reason to believe that it would cause trouble later on. The abdomen was therefore closed without drainage.

As soon as the patient's condition permitted he was given another series of six X-ray treatments between July 7, 1931, and July 18, 1931. He was discharged completely relieved of abdominal symptoms and without any palpable tumor. He has subsequently received some more X-ray treatments.

In February, 1932, he was re-admitted on account of acute bronchitis, chronic myocarditis, and auricular fibrillation, which subsided under treatment. At that time no tumor was palpable, and a barium clysma showed good outline and normal function of the bowels.

At present he is in good condition.

DR. EDWARD W. PETERSON referred to a case he had shown before this society five years ago. In July, 1918, at an operation for the relief of hydrops of the gall-bladder, it was found that the patient was also suffering with tuberculosis involving the cæcum and appendix. As the peritonitis was thought to be of the peritoneal, rather than of the enteroperitoneal variety, nothing was done at the time except the removal of the appendix and gall-bladder. Seven months later the patient was operated upon by the late Doctor Silleck for partial intestinal obstruction. Massive infiltration of the cæcum and ascending colon gave the impression of inoperable malignancy, so Doctor Silleck closed the abdomen and ordered deep X-ray therapy. A later study of the previous record convinced him that he was dealing with an extensive hyperplastic tuberculosis and not with a malignant condition. Following intensive X-ray treatment the tumefaction in the right side of the abdomen disappeared and all abdominal symptoms were relieved. For over six years the patient considered himself perfectly well, but in July, 1925, he was again operated upon for partial intestinal obstruction. An exploratory operation revealed a small tumor obstruction at the ileocecal valve, numerous scars on the cæcum, ascending colon and mesentery, but there was disappearance of the massive hyperplastic tuberculosis encountered by Doctor

DERMOID CYST OF MEDIASTINUM

Silleck at the previous operation. A lateral anastomosis between ileum and transverse colon was made, further X-ray treatment was given, and again there was complete relief of all unpleasant symptoms and rapid gain in weight and strength. This lasted until 1931, when an intra-abdominal abscess developed in the right lower abdomen. This was opened up in another hospital by another surgeon. At the present time there is a persistent sinus leading down to the ileocecal region, and a large area of ulceration of the abdominal wall of the right lower quadrant, where the X-ray treatment had been given. This report is given in answer to Doctor Eggers' suggestion that a short-circuiting operation and X-ray therapy may prove satisfactory in granuloma or tuberculosis of the cæcum. Doctor Peterson regretted that in his case radical treatment was not carried out, instead of the conservative measures mentioned.

DERMOID CYST OF MEDIASTINUM

DR. CARL EGGERS presented a woman, thirty-seven years of age, who was referred for treatment March 14, 1932, with the diagnosis of dermoid cyst of the mediastinum, which had been definitely established by her consulting physician on the basis of Röntgen-ray examinations and an exploratory puncture. Her chief complaint was dyspnoea and cough. She had not been well since June, 1930. At that time, without any premonitory symptoms, and without any warning, she suddenly had an attack of dizziness, faintness, and a feeling of compression within the chest. She was hardly able to breathe or move. There was no real pain, but a peculiar feeling of pressure and oppression which made her fearful that something might happen. She did not faint, and did not cough, and there was no expectoration. Her physician was unable to make a diagnosis and is said to have kept her intermittently under chloroform for about twelve hours. There was gradual improvement but she did not completely recover and a few weeks later consulted another doctor who diagnosed pleural effusion and aspirated it, with considerable relief to the patient. The fluid was clear and negative on culture. An X-ray of the chest was not done at that time.

The patient was seen again by this doctor in October, 1930, and he reports as follows: "An X-ray of the chest showed a curious, evenly outlined right hilus shadow with dullness on percussion. This shadow was so sharp and directly opposite the pericardium that a fluoroscopy was done, and it was definitely established that the heart, pericardium and œsophagus were not concerned. She had no symptoms and has had no symptoms except a slight discomfort on deep breathing. Several subsequent X-ray examinations have been made. The shadow and area of dullness have increased in size during the last year, and the outline has become more circumscribed. A diagnosis of mediastinal cyst was made. Recently, the patient, who is in excellent health otherwise, suffered some slight increase in dyspnoea on exertion and some feeling of chest pressure. On February 11, 1932, a paracentesis was done of the cyst itself with a very long needle, removing about ninety cubic centimetres of typical dermoid material. Since then the patient has been very comfortable and goes about doing practically everything which does not involve too much exertion. However, a radiograph taken yesterday convinced me quite definitely that the time has arrived for action."

Her doctor further reported that he had first seen the patient in consultation in August, 1928. Her chief complaint at that time had been stiffness and swelling of the neck, particularly on the right side, which had been preceded by pain in the right arm and shoulder. She also complained of tightness in the throat and difficulty in swallowing. He subjected her to a

very careful physical examination at that time, including an X-ray study of the chest. Nothing was found which apparently had any relation to the later diagnosis of mediastinal cyst. His only definite finding was an impacted right upper molar. After its removal all symptoms promptly disappeared.

When seen by Doctor Eggers March 14, 1932, her general impression was good. There was moderate dyspnoea, even on slight exertion. The general examination was negative.

The lower part of the neck looked widened and full, but nothing abnormal could be palpated. The thyroid was not enlarged.

Over the upper anterior chest there were numerous dilated superficial

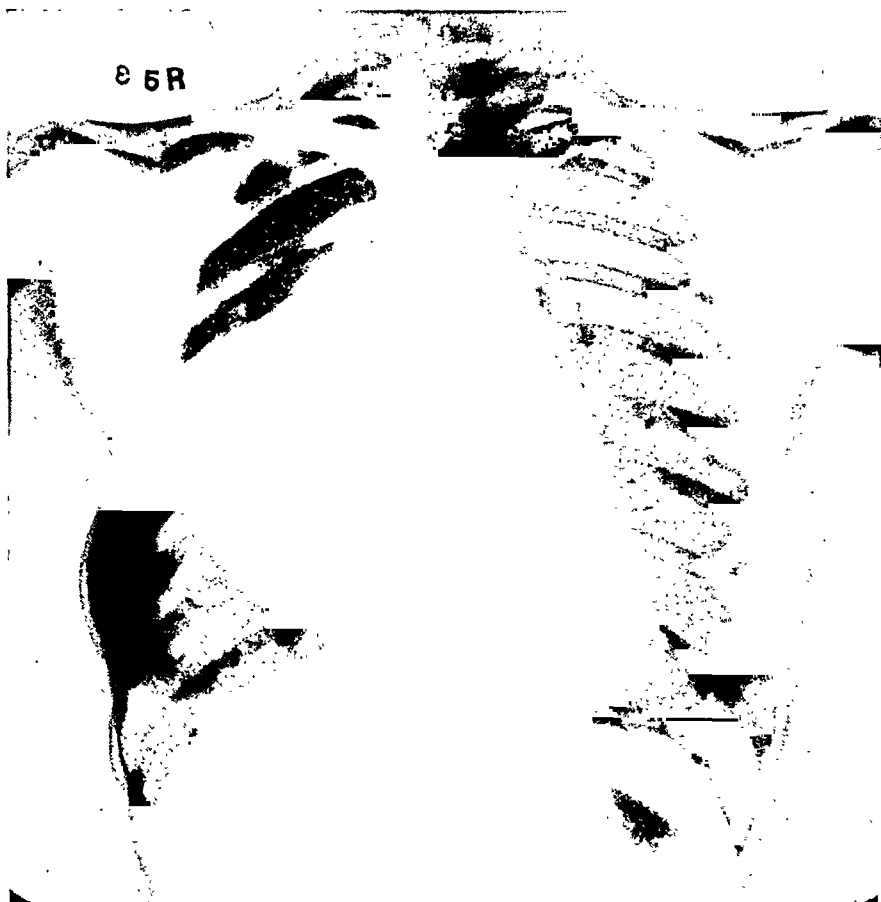


FIG. 2.—Mediastinal dermoid cyst, capacity 1,000 cubic centimetres, before operation.

veins which extended laterally from the upper sternal region over both sides. On inspiration there was marked retardation noted over the right side.

Posteriorly nothing abnormal could be made out, while anteriorly there was flatness on the right side, extending from the second rib downward to the diaphragm. It extended beyond the median line on the left and to the anterior axillary line on the right. Breath sounds were present over the entire area, however, and seem quite normal.

The heart sounds were slow, regular, good force, 90 per minute.

As soon as the patient lay down her face and neck became acutely red and swollen, and her eyes bulged and began to water.

The impression one got is that there was pressure on the large vessels, rather than on the trachea. As soon as she sat up the condition readjusted itself.

DERMOID CYST OF MEDIASTINUM

An X-ray examination showed a large cone-shaped shadow in the right chest, with its base in the mediastinum and its tip almost in the axillary line. The margins were smooth and sharply defined. (Fig. 2.) Operation March 17, 1932. Under local $\frac{1}{2}$ per cent. novocaine anaesthesia a slightly curved incision was made over the right anterior chest with the convexity towards the left. It extended from the second to the fifth ribs about at the junction of the ribs with their cartilages. The breast and pectoral muscles were displaced outward. About four to five centimetres of the third, fourth, and fifth ribs were removed just distal to the junction with the cartilages. The intercostal tissues were dissected back, and immediately underneath was felt a large, tense mass. The exact location of the pleural reflection could not be determined. An exploratory puncture was done and light brown, thick, non-odorous fluid aspirated. A large trocar was then inserted and about 1,000 cubic centimetres of this same type of fluid and cheesy material removed by suction. (Reported negative for organisms and pus-cells.) The patient immediately experienced great relief.

After evacuation the cyst-wall collapsed somewhat and further exploration was possible. The pleura was found to be densely adherent to the outer side of the sac, but nevertheless the condition looked rather promising for complete extirpation in one stage. In attempting to shell out the sac the pleura was entered in several places, but apparently there was no free pleural cavity but only smaller pockets separated by adhesions. As a result of this the lung did not collapse and the patient had no distress. It was possible to completely separate the lung from the mass. In the other directions the separation was more difficult. In order to be able to proceed cautiously the sac was opened and dried with sponges. It was enormously large. Towards the left and in an upward direction it was impossible to palpate its limits; it reached beyond the median line into the left chest. Part of the lining was quite smooth, while other portions were thick, knob-like masses of skin, with a pigskin appearance, from which hairs grew, of which none seemed more than about an inch in length. With one finger in the sac acting as a guide, a further attempt was made to free the sac, but it was very difficult, especially opposite the thick, knob-like portions. The third and fourth costal cartilages were now completely removed, but even then much of the dissection had to be done without the aid of vision, especially under the sternum and in an upward direction. The strain was beginning to tell on the patient, but her color was good and she was cheerful. It was considered inadvisable to attempt complete extirpation in one sitting. There was danger of severe hæmorrhage. Marsupialization was decided on. Sac therefore freed somewhat more in all directions until it was possible to draw its opening well out of the chest. While freeing it from the pericardium in the depth the right phrenic nerve was divided. A gauze tampon was now packed into the sac and the edges were then sutured to the margins of the skin at the site of the third and fourth costal cartilages, close to the sternum. A large piece of rubber dam was inserted between the outer wall of the sac and the right parietal pleura. The rest of the wound was then closed with interrupted silk sutures.

The convalescence was uneventful except for a rise of temperature to 103° on the second night. There was at the same time considerable cough and pressure sensation in the chest. It was promptly relieved by removing the large gauze packing from the cyst which had become saturated with secretion and by its weight produced symptoms of pressure. The patient was

turned on her abdomen several times and in that position completely drained the cyst with relief of symptoms.

She was allowed out of bed on the tenth day and her progress had been uninterrupted, until she was completely free of symptoms. At the completion of the operation it was expected to follow with a second stage in about two weeks, even though the difficulties connected with the extirpation of the sac were known. However, several points of interest had been noted which made him hesitate. The sac had shrunk to such a degree that it was now possible to feel its limits in all directions. The secretion had markedly diminished. The pathological examination of part of the excised wall of the sac had

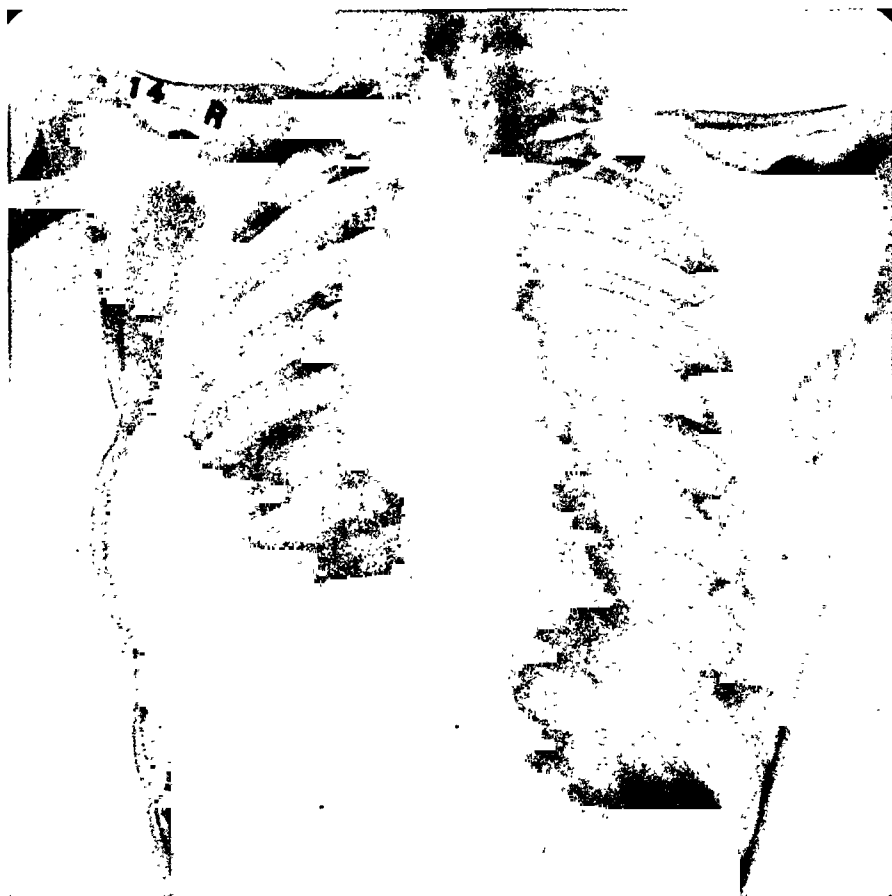


FIG. 3.—Mediastinal dermoid cyst twenty-five days after operation. Capacity thirty cubic centimetres.

shown that it was devoid of distinctive lining membrane, though in other parts there was thick skin with hair. This awakened feeling that there was reason to hope for considerable more contraction of the sac until only that portion remained which had a definite epithelial lining. It might be possible to later destroy that with an electric cauter. At present he was waiting to see what nature would do.

Injection of the remaining cavity three weeks after operation showed that it held only about thirty cubic centimetres. (Fig. 3.) An X-ray taken at that time demonstrated this small residual cavity.

DR. ALLEN O. WHIPPLE said that about two years ago he had a patient at the Presbyterian Hospital on whom he operated for a cyst in the right

HYRONEPHROSIS AND MEGALO-URETER

side, thought to be a dermoid cyst of the mediastinum or pleura, that gave remarkable findings. She had suffered from the lesion for over twelve years and had had repeated tappings. Her chief symptom was dyspnoea, so severe that she could not lie down, but the tappings relieved this. Because of the necessity for repeated tappings it was decided to do an exploratory thoracotomy. On reaching the main cavity, peculiar knob-like thickenings were seen on the floor of the cyst. One of these was removed and was found to communicate with other cysts. Because the patient's condition was not good, further measures had to be stopped, only marsupialization being done. The patient developed a massive lung collapse on the other side and died from pneumonia. Autopsy showed the cyst was an echinococcus cyst, not a congenital one, of the pleura.

DOCTOR EGGERS rejoined that one of the interesting points in the history of his patient was the acute onset with a feeling of pressure within the chest and dyspnoea so severe as to require the administration of chloroform. This point, together with the pathological examination of a part of the wall of the sac which was devoid of a definite epithelial lining, and the further fact that the capacity of the sac had diminished from 1,000 cubic centimetres to thirty cubic centimetres in three weeks, seemed very significant. He wondered whether the original dermoid cyst could have ruptured spontaneously and in addition to the primary tumor have developed a large secondary sac. This explanation seemed to him the most likely, as one would hardly expect as rapid a diminution in size of a tumor completely lined with epithelium.

HYDRONEPHROSIS AND MEGALO-URETER

DR. CARL EGGERS presented a young man, twenty-two years of age, who came under surgical care at the Lenox Hill Hospital February 26, 1931, complaining of attacks of pain in the left side of the abdomen for twelve years. He stated that he had been sick practically all his life. As a small child his tonsils were a constant source of trouble until they were removed. About twelve years ago he had first attack of pain in the left flank. It was sufficiently severe to cause him to hold his side and to double over. It did not radiate. There were no definite urinary or intestinal symptoms. The pain was constant and lasted about three days. Following this original attack he had others at the rate of about one every six months. For several years there was complete relief, but about six months ago the attacks came on again, at the rate of about every two weeks. Some lasted about twenty-four hours, while the last one, a week before admission, continued for three days. His only symptom in addition to pain was occasional urgency.

There was nothing in his personal habits to indicate relation to his symptoms and the only point of interest in the family history was the diagnosis of kidney and bladder stones in the mother.

On examination there was tenderness in the left costovertebral angle and on bimanual examination a large mass was palpable in the kidney region, extending down to the crest of the ilium. There was no muscular rigidity, but considerable tenderness over the mass and also along the course of the ureter. The right kidney was palpable but not tender.

Rectal examination revealed a small prostate. There was no tenderness on the right side, but on the left side, corresponding to the region of the entrance of the left ureter, there was infiltration and tenderness. The external genitals were normal. The urine was slightly cloudy.

A few days' observation, associated with urine examinations, repeated cystoscopies and X-ray examinations brought out the following points: The urine at times was clear, then again cloudy. There was no fever. The large mass in the kidney region completely disappeared with relief of pain. Cystoscopy showed a normal bladder and both ureters were easily catheterized. On the right side clear urine was obtained, indigo-carmin in good concen-

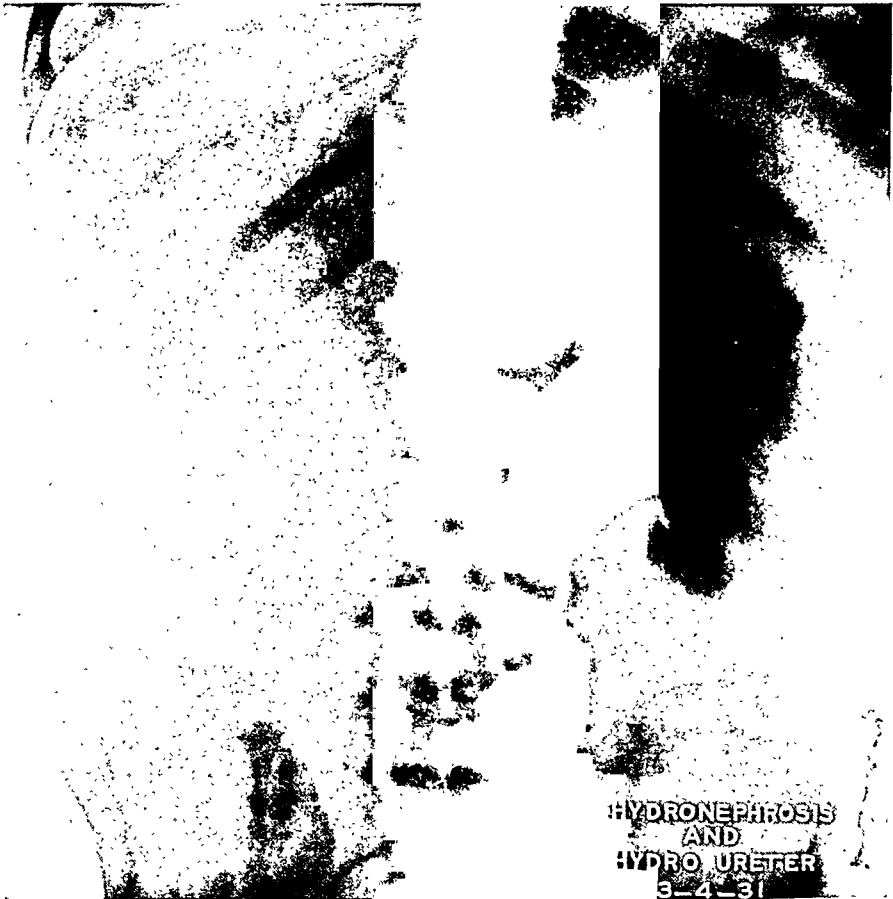


FIG. 4.—Hydronephrosis and hydro-ureter injected with sodium-iodide solution.

tration was received in five minutes. On the left side slightly turbid urine was collected but no indigo-carmin was excreted. A pyelogram done on the left side by blocking the ureteric orifice and injecting twenty cubic centimetres sodium iodide showed a pouch-like area size of a hen's egg just above the bladder, while the kidney and ureter were not outlined.

These various findings pointed to an old, rather quiescent suppurative lesion of the left kidney and ureter, probably not tuberculous in nature. The large mass which was felt on the original examination must probably be considered a hydronephrosis. A cystoscopy was therefore repeated for the purpose of filling and outlining the suspected sac. About 300 cubic centimetres sodium iodide were injected into the left ureter without causing any discomfort and the accompanying picture obtained. (Fig. 4.) There was present evidently

HYPERTROPHY OF THE PYLORUS WITH ULCER OF THE STOMACH

a hydronephrosis and a megaloureter. The etiology of the condition could not be determined.

In order to establish permanent drainage of the hydronephrosis and to overcome the existing infection of *Staphylococcus albus*, a catheter was inserted into the left ureter and allowed to drain continuously. At intervals the hydronephrotic sac was irrigated and collene then injected. This was continued for four days. Reconsideration of the case, and the realization that we were dealing with a large potentially infected sac with no kidney function, which represented a menace to the future welfare of the patient, made us decide in favor of extirpation of the whole mass, which was done March 18, 1931, through a left Langerbeck incision.

The hydronephrotic sac was gradually drawn out of the wound without resecting the twelfth rib. It was very adherent. After freeing it completely the vessels of the pedicle were doubly ligated and divided. A greatly dilated pelvis of the kidney and upper end of the ureter were freed and dissected downward. While doing so the ureter tore off about five inches below the pelvis, and was ligated at this point. A complete ureterectomy was not possible through the kidney incision. A cigarette drain was therefore inserted into the upper wound and the layers of the abdominal wall were closed around it. The patient was then turned on his back and a median suprapubic incision made. The bladder was freed extraperitoneally and the ureter isolated. It was much dilated. It was followed upward and when the stump was freed it was drawn down. By gentle traction and blunt dissection the ureter could be followed completely down to the bladder. It was then found that the lowest inch was only slightly dilated. No stricture or other abnormality could be made out and there was no aberrant vessel producing angulation or pressure. It was ligated with chromic catgut close to the bladder and the stump cauterized. One cigarette drain was inserted into the pelvis and the wound closed around it.

On the following evening the temperature rose to 103°, but on the sixth day it had reached normal and remained there. The convalescence was uneventful, and the patient was discharged cured on the thirty-second day. He has had no trouble since.

The specimen was constructed after operation by suturing the divided ureter and it was then filled with fluid in order to be hardened. It took almost 1,000 cubic centimetres to fully distend it.

DR. EDWIN BEER said that the interest of this case lies in the pathology from the surgical standpoint. When one encounters an enormous ureter of this sort with no pathological condition at operation to explain it, one is liable to regard it as a congenital megalohydronephrosis. In the speaker's opinion, causes may have existed in earlier life which led to enormous distention of ureter and kidney, which have disappeared at the time of operation, and the most likely would be a stone in infant life or during early childhood. As far as operation is concerned, Doctor Beer believes that total aseptic nephro-ureterectomy without opening the urinary channels should be done more often than it is. He has had forty cases on his service at Mount Sinai Hospital with no mortality.

HYPERTROPHY OF THE PYLORUS WITH ULCER OF THE STOMACH

DR. WILLIAM BARCLAY PARSONS, JR., presented a man, fifty-eight years old, who came to the hospital in November, 1931, complaining of recurring

epigastric pain. Two years ago he began to complain of epigastric pain coming on at irregular intervals from two to four hours after meals.

Under treatment he was relieved and his health had been excellent until three weeks prior to the present admission. At this time he again noticed pain occurring two to four hours after eating. The pain was located in the epigastrium, radiating to both the right and left and, at the few times when very severe, to the interscapular region. There was neither nausea nor vomiting at first. Eructations helped slightly, and soda gave distinct relief. His intermittent pain is usually at night.

The gastro-intestinal X-ray showed normal tone and peristalsis of the stomach, but a constant filling defect involving the lesser curvature portion of the pre-pyloric zone. He had no anæmia. Blood Wassermann was negative. The stools were negative for blood. His appetite was excellent, and his history of pain with relief by soda and prompt subsidence of symptoms with alkalies and diet was certainly more in favor of ulcer than carcinoma.

At operation the following pathology was found: The stomach was small, flexible. Just proximal to the pylorus, on the lesser curvature side, was a lesion roughly two and one-half centimetres in diameter. The overlying peritoneum was puckered. The mass was irregular, and it was doubtful whether it represented a small carcinoma or merely the thickening of an ulcer with a crater and irregular margins. No enlarged glands were found.

A partial gastrectomy was done. The crushing clamps were applied at a convenient point above the incisura, the stomach immediately distal to the clamps being soft and flexible, apparently the entire pathological region being just pre-pyloric.

Pathological Findings.—Gross.—The specimen consisted of a segment of stomach which measured six centimetres along the lesser curvature and thirteen along the greater. At the distal end there was palpable in the wall a distinct thickening which came within about three milligrams of the cut end. This was most marked on the anterior surface but also extended along the greater curvature, and up the posterior aspect. It was about two centimetres broad. The peritoneum over it was not stippled.

On section this thickening apparently consisted of a very marked hypertrophy of the musculature above which the mucosa and submucosa were distinctly outlined and were apparently free from tumor or ulcer. One centimetre from the proximal end of the stomach on the lesser curvature there was a punched-out ulcer with rolled edges, one centimetre in length and eight milligrams in breadth. It was oval with the long axis along the lesser curvature. On section this ulceration was found to interrupt the muscular coat but there was no marked thickening of the ulcer edges. It did not look neoplastic grossly.

Two small, soft, lymph-nodes about three milligrams in diameter were found in the omentum on the lesser curvature and one five milligrams in diameter on the greater curvature. This was partly replaced by fat.

Microscopical.—Section through the ulcer showed that the ulcer bed was covered with slough and that it rested upon a mass of scar tissue which completely erupted the muscular coat and extended out into the subserous layer. Caught in this scar tissue were a number of nerve bundles which were surrounded by thick-layered fibrous tissue. In the ulcer bed immediately beneath the necrotic tissue were many capillaries which came close to the surface. The scar tissue was infiltrated with great numbers of eosinophilic leucocytes. The mucous membrane at the margins of the ulcer was exceedingly vascular and showed distortion of the glands with some hyperplasia. A few of the glands were dilated and formed tiny cysts.

Sections through the pylorus showed a tremendous thickening of the pyloric muscle which was 1.3 centimetres at its thickest point and one centimetre wide. The mucous

THYROGLOSSAL FISTULA WITH SUBMENTAL OPENING

membrane covering was intact and toward the stomach side was infiltrated with eosinophilic leucocytes and large cells with small nuclei and large, rounded, acidophilic masses in the cytoplasm. These might be plasmocytes. There was no evidence of cancer either here, in the region of the ulcer, or in the region of the lymph-glands.

Diagnosis.—Ulcer of stomach. Hypertrophy of pylorus of stomach.

The points of interest in this case are: First, the history was unquestionably due to the ulcer, and the thickening of the pylorus was in all probability not associated with any symptoms, although giving a filling defect on X-ray examination, suggesting pre-pyloric carcinoma. Second, the ulcer was not shown radiographically, and was not appreciable by inspection or palpation of the stomach, and was found only by the good fortune in having placed the clamps above it. This point emphasizes the importance of opening the stomach and inspecting the mucosa in cases of suspected ulcer where palpation has not convinced the surgeon of the presence of an ulcer.

THYROGLOSSAL FISTULA WITH SUBMENTAL OPENING

DR. WILLIAM BARCLAY PARSONS, JR., presented a man, twenty-seven years of age who came to the hospital because of a draining sinus in the neck which had been present for twenty-five years. This sinus was situated in the mid-line half way from the hyoid bone to the point of the chin in the submaxillary region, and had always discharged clear white fluid. There had been no pain, and nothing seemed to affect the amount of discharge except for brief periods when a crust would form. Except for a twelve-year history of chronic otitis media on the left, associated with a mastoidectomy, the previous health was quite unimportant. The Wassermann reaction was negative. Ear examination showed purulent discharge with an absent drum membrane. The oro-pharynx was congested. Tonsils were of moderate size.

Injection of the tract with lipiodol showed the tract running from the submaxillary region back to the hyoid bone and from there in general upward towards the foramen cæcum, with several small branching processes just above the hyoid bone. This demonstrated quite definitely that the condition was a thyroglossal fistula with an unusual level for the anterior opening.

The operation, as performed, was the typical one described by Sistrunk. The tract was cored out to the hyoid bone, a section of which was then removed. The tongue tract was then similarly cored out. One of the branches of the tract was seen before being divided, as it had been injected with methylene blue. This tract led directly backward just above the hyoid bone to the anterior pharyngeal wall. This was divided at the mucous membrane and was inverted beneath a purse-string suture of fine silk. The terminal portion of the duct was clamped and coagulated with a coagulating current.

The microscopical report was as follows:

"The section of the tract near the skin surface shows that it is lined with stratified cuboidal and cylindrical, ciliated epithelium. Some of the cells have vacuoles in them containing mucin. The tract in this portion is surrounded by a thick layer of dense fibrous tissue outside of which is striated muscle and fat. A section of the tract near the hyoid bone shows that it is lined with cuboidal epithelial cells without recognizable cilia but with occasional droplets of mucin. In this region there are many short, accessory branches which are found in the surrounding fibrous tissue. Together with these are some acini with colloid-like material in them, which are probably accessory thyroid acini. Another section near the hyoid shows two other fistulous tracts lined with stratified cylindrical ciliated epithelium and surrounded by striated muscles. *Diagnosis.*—Thyroglossal fistula."

TUMORS OF THE SMALL INTESTINE

DR. HENRY W. CAVE read a paper with the above title for which see ANNALS, August, 1932, p. 269. The reading of the paper was prefaced by the presentation of two patients:

CASE I.—A man forty-one years of age, was admitted to the Leroy Sanitarium March 25, 1931, complaining of weakness following collapse after a severe intestinal hæmorrhage.

For the past three years the man has had an indefinite pain in the abdomen, irregularity of bowel movements and considerable flatus. Appendix was removed some years ago. Two years previously had been treated for colitis. In February, 1929, a gastro-intestinal series was done which proved to be negative. The gall-bladder visualization at the same time showed the gall-bladder to be apparently normal.

His present illness began in the late afternoon of March 25, 1931, when, while preaching a Lenten service, he suddenly collapsed and was unconscious for a few minutes. He was taken to his home and then to a sanitarium. After arrival at the sanitarium he had a large bowel movement in the evening which without question contained a considerable amount of old blood, a copious, dark, tarry stool.

His hæmoglobin was 45 per cent.; Red blood-cells, 2,250,000. The following day he had a transfusion. During the next month he had several very large hæmorrhages while he was in the hospital. Numerous complete gastro-intestinal series were taken, all of which proved to be negative, until, on May 8, 1931, the röntgenologist reported a constant small diverticulum of the third portion of the duodenum. He also states that this was not noted on the plates taken a month previously, but a review of these former plates in light of this finding showed an instance of its presence. He goes further to state that this diverticulum has become larger in the past few weeks and might be a perforating ulcer of the third portion of the duodenum.

Pre-operative Diagnosis.—Bleeding diverticulum of the third portion of the duodenum. *Diagnosis at operation.*—Tumor of the jejunum approximately ten inches from the duodeno-jejunal junction.

Procedure.—Resection. Side-to-side anastomosis.

Pathological Report.—Leiomyoma of the jejunum.

This case was presented as one with unusually severe hæmorrhages from a tumor of the jejunum, to emphasize that early exploratory celiotomy is justifiable in indeterminate intestinal hæmorrhages.

CASE II.—A woman, forty-five years of age, entered Roosevelt Hospital October 16, 1927, complaining of pain in the right upper quadrant of the abdomen. Her present illness began about one year ago with a vague feeling of depression and also distress in the right upper quadrant of the abdomen. Particularly has this discomfort been aggravated after eating of meat. Aside from these symptoms and a few vague aches and pains in the back, her present illness has been unimportant. Except for a tenderness in the upper abdomen just to the right of the mid-line in the epigastrium her physical examination was entirely negative.

X-rays.—Her gall-bladder showed a very faintly visualized, small, contracted gall-bladder with a poor concentration of dye; no stones identified. It was set down that failure to concentrate was due to a functional or some inflammatory mucosal changes; the dye test was considered only suggestive. However, a pre-operative diagnosis of chronic cholecystitis was made.

TUMORS OF THE SMALL INTESTINE

Operation.—Revealed a grayish-colored, distended gall-bladder which did not empty readily. It was the shape almost of a dumb-bell with a constriction or neck at the junction of the middle and lower third; there were no stones. Cholecystectomy was done.

On examining the duodenum there was found to be present a small tumor one centimetre distal to the pyloric vein and lying in the anterior wall of the intestine. It was small, approximately one centimetre by one centimetre, rounded, surface roughened, no crater distinguished; the tumor mass seemed to extend throughout the entire thickness of the intestinal wall. It was excised.

Microscopical section of this tumor showed normal mucous membrane, the interlacing bundles of smooth muscle being separated in places by masses of epithelial cells. These epithelial cells are arranged in solid masses supported by delicate tissue stroma and duct-like structures having a fibrous sheath. The individual cells have a uniformity in size, shape and staining properties. Some of the cells are arranged so that they resemble islands of Langerhans.

Diagnosis.—Accessory pancreatic tissue in duodenum.

This patient was shown on account of the symptom of increased epigastric distress while eating meat from which she has been entirely cured since her operation in October, 1927, a period of over four years; and also for the reason that perhaps the removal of her gall-bladder alone might have cured her of her complaint. It would be difficult to tell which condition was causing her discomfort.

It is stated by a physiologist that meat when eaten causes a more rapid secretion of pancreatic juice than either milk or bread. Therefore, in this case a distention of the pancreatic tissue confined within the wall of the duodenum may have been the source of her complaint. However, it is my own opinion that her gall-bladder was the inciting cause of her symptoms.

DR. JOHN MCCREERY said that of the disease, presented by Doctor Cave, in Bellevue Hospital there have been only seven cases in 160,000 admissions. Two years ago McWhorter and McCloud studied a series of 13,000 autopsies and found only six cases, three carcinomas and three sarcomas. The interesting point brought out in this study was that metastasis in the carcinomas was very slow, so that if early diagnosis were possible, operation might be expected to have favorable results. On the other hand, the cases of sarcoma metastasized very rapidly and widely spread. As far as diagnosis is concerned, an early one was made rarely. Early diagnosis depends on accident, such as intussusception or volvulus. He showed photographs of three cases of carcinoma. The first was a man who gave no symptoms until two weeks before his admission to the hospital. The second case, a lipoma, had a long previous history of pain due to attacks of mild intussusception. The X-rays had been unsatisfactory in all the cases.

TRANSACTIONS

OF THE

PHILADELPHIA ACADEMY OF SURGERY

STATED MEETING HELD MARCH 7, 1932

The Vice-President, DR. WALTER E. LEE, in the Chair

DR. CALVIN M. SMYTH, JR., Recorder

RETROPERITONEAL SARCOMA

DRS. E. L. ELIASON and L. K. FERGUSON presented a woman, aged thirty-eight years, who was admitted to the Medical Service of Dr. Alfred Stengel, October 10, 1927. She complained of epigastric distention, belching and indigestion, associated with a throbbing over the epigastrium. Eight months before admission the patient noted an egg-sized mass in the abdomen at the level of the umbilicus. The mass gradually increased in size. For the month preceding admission she had a marked gastric distention immediately after taking any sort of food. There was an associated pain in the upper abdomen unrelieved by soda which gradually disappeared after epigastric massage. Her appetite was good. After each meal defecation was necessary. Her stools were soft or semi-liquid but did not contain blood. She noted in addition an increasing œdema of the ankles, and slight frequency of urination with nocturia two to four times. There was no loss of weight, her average being 134 pounds. She weighed on admission 137 pounds. Her past medical history was not significant. An interval appendectomy was performed five years before admission. There was a systolic murmur at the base of the heart. In the left epigastrium was a firm, round mass measuring eight inches in diameter. The mass was freely movable in the abdomen and the skin moved over it. It seemed to extend somewhat under the left costal margin.

The routine examinations of the blood and urine were within normal limits as were the various blood-chemistry determinations. X-ray examinations of the gastro-intestinal and urinary tracts showed no significant abnormalities except for a deformity of the greater curvature of the stomach, and a suggestive outline suggesting a tumor which was disclosed by a barium enema.

She was readmitted December 1, 1927, to the surgical service of Doctor Eliason. Since her previous admission she had had frequent attacks of vomiting after eating and had developed a backache in the lumbar region. At operation December 2 a mass about seven inches in diameter was exposed. It was round, fairly firm, smooth and covered by the anterior layer of the transverse mesocolon. Many large veins surrounded it. After dividing the anterior mesocolon, a friable tumor was exposed which bled freely. The mass was carefully freed from the anterior and posterior layers of the mesentery. Removal of the tumor showed clearly its location between the layers of the transverse mesocolon. It was well encapsulated and apparently entirely removed. It was pronounced by the pathologist to be a spindle-cell sarcoma. The post-operative course was uneventful. She was discharged fifteen days after operation.

Examination December, 1931, showed the abdominal wound well healed; no symptoms; no abdominal masses palpable.

SPLENECTOMY FOR SICKLE-CELL ANÆMIA

DR. FREDRICK A. BOTHE reported the case of a colored boy, two years and ten months of age, who was admitted to the Children's Hospital April 3, 1930, with the

SPLENECTOMY FOR SICKLE-CELL ANÆMIA

statement that the child had cried considerably for the past five months, was very restless, and had had repeated attacks of fever. These attacks occurred every five to ten days and lasted twenty-four to forty-eight hours. He had also suffered from frequent colds. When admitted his temperature was 101° ; pulse, 140. He was very fretful and restless. There was definite evidence of rickets, but the abdomen was distended out of proportion to the other rachitic findings. The spleen was greatly enlarged. It extended to the umbilicus on the medial side and down to the crest of the ileum. A blood count revealed a hæmoglobin of 18 per cent.; red blood-cells, 1,000,000, and white blood-cells, 36,000; neutrophiles, 21 per cent.; lymphocytes, 70 per cent.; large mononuclears, 2 per cent.; transitionals, 2 per cent.; eosinophiles, 6 per cent.; basophiles, 1 per cent.; poikilocytosis was slight; achromia marked; megoblasts, 1 to 7 per 100 leucocytes; normoblasts, 5 per 100 leucocytes. The red blood-cells were positive for sickle-cell formation in an anaërobic preparation. The blood of the child's father, mother, and sister was also positive for sickle-cell formation. He remained in the hospital for five months, receiving repeated blood transfusions. During the early part of hospitalization the attacks of fever occurred every five to ten days and would last six to eight days. As his condition improved the attacks became of shorter duration and the interval between attacks was longer. He was discharged from the hospital September 8, 1930. At this time the hæmoglobin was 45 per cent.; red blood-cells, 3,880,000, and white blood-cells, 24,000. Thirteen days after discharge he was readmitted with a high fever and a recurrence of former symptoms. In addition, the child was suffering from a bloody diarrhœa and pain in the right elbow. No bloody stools were found after admission to the hospital, and the pain in the elbow disappeared in forty-eight hours. The hæmoglobin had fallen to 27 per cent., and the red blood-cells to 2,150,000. The fever persisted for three weeks. Again repeated blood transfusions were resorted to in an effort to overcome the severe anæmia. Eight weeks later the symptoms noted above recurred and in addition pains in the legs and an occasional pain in the abdomen developed. As the symptoms were becoming more pronounced and additional symptoms appeared a splenectomy was done March 27, 1931. The spleen was easily mobilized and delivered. Many enlarged nodes, probably hæmolymph-nodes, were found in the pedicle. The spleen weighed 295 grams. Microscopical studies showed the pathological changes characteristic of the spleen in sickle-cell anæmia. There was a fair degree of fibrosis and an occasional giant cell was found. Within the giant cells, elongated bodies are seen which Jaffe believes are fungi. An uneventful recovery followed and a gradual improvement in the general condition. The blood elements showed a definite improvement. Numerous observations have been made in the dispensary since his discharge from the hospital. Six months after the operation he was readmitted, complaining of a pain in the right elbow. This was accompanied by a fever of 101° . The symptoms and the fever disappeared in forty-eight hours. A blood count at this time showed the hæmoglobin was 59 per cent.; red blood-cells, 3,680,000, and white blood-cells, 29,200; neutrophiles, 69 per cent.; lymphocytes, 30 per cent.; large mononuclears, 1 per cent.; polychromatophiles marked; anisocytosis moderate. No megaloblasts found, three normoblasts found, while counting 100 leucocytes.

One year after the operation, the general appearance of the child was greatly improved and he had gained weight. The mother stated he had had only a few mild attacks of fever, and slight pains in the legs about once a month, but in general the symptoms in the attacks were much milder. There has been no recurrence of the pains in the abdomen. The child was observed in the hospital for two weeks and during that time was symptom-free and there was no fever. There was no appreciable change in the blood-picture from the examination made six months previous.

DOCTOR BOTHE remarked that it is hard to estimate just how much benefit the splenectomy is going to do this child. Though he has not been entirely

relieved of symptoms, the interval between the attacks is much greater in length, and the attacks are not so severe. The symptomatic improvement is apparent when contrasted with the untoward progress of symptoms as noted with each succeeding admission prior to operation.

Sickle-cell anæmia is a disease which is almost entirely limited to Negroes. In the past few years, however, Castana, Stewart, and Lawrence have all reported cases that have occurred in the white race. Two distinct conditions are known: (1) Sickle-cell trait, or sicklæmia, as suggested by Stewart; and (2) the active phase of sickle-cell anæmia. In patients showing the sickle-cell trait the red blood-cells will undergo transformation into the "oats" and "sickle" shapes in an anaërobic preparation. When the sickling occurs in the circulating blood and anæmia develops, it is considered the active phase. Patients who develop the active phase usually die before thirty years of age. Studies have shown that approximately 7 per cent. of all Negroes have the sickle-cell trait and a small percentage of this group develops the active phase. The cause for the sickle-cell formation is not known. Joseph believes it is due to a disturbance of hæmatopoiesis, in which the red blood-cells are effected so that they absorb an unknown substance common to all blood plasma which normal cells will not absorb. This substance remains attached to the surface of the cells, probably lowering the surface tension. It can be washed off in salt solution, after which the cells assume normal shape; when placed again in blood plasma, whether of a normal individual or of one possessing the sickle-cell trait, the abnormal forms reappear to the same extent as originally. The anæmia itself is due to hæmolysis and phagocytosis of the red blood-cells. The following is a brief description of the disease:

Symptoms.—The most constant symptoms are weakness and fatigue accompanied by fever. Pains in the extremities are common, and in many cases predominate. The most frequent locations of these pains are the upper end of the tibia and the vicinity of the ankle-joint. The classical symptomatology and local findings of acute osteomyelitis is not uncommon. Cases have occurred in which the differential diagnosis has been so difficult that caution should be used in operating upon Negro children until the blood has been studied to determine whether sickle-cell anæmia or a true osteomyelitis is the cause of the symptoms and local findings. In some cases severe pain in the epigastrium simulating an abdominal crisis is the outstanding symptom. Pain and stiffness in the muscles may occur. These patients are very prone to develop ulcers on the extremities even from minor traumas because of the lowered resistance. The fever is usually about 101° to 102°. These symptoms occur in attacks at about three- to six-week intervals and last from five to fourteen days.

The pathological changes present are so similar and so constant that it may be said that sickle-cell anæmia is a definite entity from the standpoint of pathological anatomy. The most significant pathological changes occur in the spleen and the bone-marrow. The capsule of the spleen is thickened. This organ is usually overfilled with blood, contains a large amount of pigment both iron-free and iron-containing. The trabeculæ are much more prominent than normally due largely to the atrophy and disappearance of the pulp. Many trabeculæ are found moderately impregnated with dense calcium. The Malpighian corpuscles are either small or have disappeared beyond recognition. The arterioles and capillaries are much congested. The sinuses are dilated and contain many bizarre forms of erythrocytes. Hæmosiderin granules can be found in clumps through-

SPLENECTOMY FOR SICKLE-CELL ANÆMIA

out the section. Early in the disease there is a progressive enlargement of the spleen. In the later stages fibrosis occurs throughout the splenic pulp with resulting contracture in size and weight. Cases have been reported in which the spleen weighed less than fifty grams. There is a general lymphadenoid hyperplasia and a hyperplasia of the bone-marrow affecting both the red and white blood-cell elements. This is believed to be the result of some chronic injury to the bone-marrow with repair and compensatory hyperplasia.

Splenectomy was first suggested as the treatment for sickle-cell anæmia by Sydenstricker and Huck in 1924. They advanced the following indications for splenectomy: (1) Excessive hæmolysis; (2) compensatory activities of the hæmopoietic tissues evidenced by an excessive output of nucleated and reticulated red blood-cells and high white blood-cells; (3) splenomegaly; (4) evidence of splenic involvement by crises of abdominal pain. Since these observers have published their careful studies and the findings that they believe are indicative of splenectomy, greater interest has been stimulated in that form of treatment for sickle-cell anæmia.

It is generally believed that the spleen plays more than a minor rôle in this disease. Many more splenectomies have been performed in this condition than have been reported in the literature. From the meagre experience to date, with splenectomy in this form of anæmia, most observers feel that splenectomy should be performed early. Once fibrosis has occurred and the spleen has contracted, little or no benefit is to be expected. In the case just reported, the splenomegaly had persisted over a year, to our knowledge, and there was a fair degree of fibrosis throughout the splenic pulp. This may explain why the symptoms were considerably relieved, but a symptomatic cure was not obtained. Perhaps at a later date greater improvement may occur. Hahn and Gillisipe reported the first case in 1927, two years after operation, that was entirely relieved symptomatically. Subsequently, four cases have been reported in which the spleen has been removed. Two patients became symptomatically well, and in another case there was temporary relief. In one case the spleen had contracted, and at the time of removal weighed only forty-six grams. Though the symptoms are relieved, the sickle-cell trait persisted, just as the increased fragility of the red blood-cells persists, following splenectomy for congenital hæmolytic icterus though the disease has been symptomatically cured.

DR. RALPH S. BROMER, by invitation, said that the question might be asked whether the prominence in this child's skull, posterior to the anterior fontanelle, could be due to rickets, inasmuch as other clinical signs of rickets were present. In rickets, the so-called bosses occur most frequently in the frontal area. This prominence is due to thickening of the outer table, but nowhere can any so-called perpendicular striations be seen. In the congenital anæmias of childhood, especially the Cooley type, such striations are seen arising from the outer table and also are seen connecting the outer and inner tables. Striations connecting the outer and inner tables are found in normal individuals as pointed out by Pancoast and Sosman. Perpendicular striations

extend outward from the outer table and inward from the inner, in cases of meningioma. These points are essential in the differential diagnosis. Many case reports of sickle-cell anæmia mention the fact that no bone changes were present. It seems it can be taken for granted in this case that the thickening and raising up of the outer table are due to the anæmia but the process has not advanced to the stage of perpendicular striations as found in the cases of erythroblastic anæmia as described by Cooley.

DR. GEORGE P. MULLER said that in September, 1926, he did a splenectomy for this condition in an octo-roon boy. At the time of operation the spleen was exceedingly small; the case was reported later by Stewart, in 1927. At the time they were skeptical of the value of the splenectomy as the spleen had gone on to complete fibrosis. This boy was studied in 1931, is perfectly well, has grown, but still has anæmia, 54 per cent. hæmoglobin, 2,000,000 red blood-cells and sickle cells.

DOCTOR BOTHE said that the finding of a hypernephroma in a patient so young is unusual, although they are occasionally reported under ten years of age. The location is very unusual. Adrenal rests of the liver have been reported as well as primary hypernephromata, the former very much more frequent. The speaker knows of no case of primary hypernephroma of the liver in early infancy. Unless one studies this tumor closely, histologically it might easily be interpreted as a mixed tumor. The cells, however, are of the same type throughout. They appear as those found in the zona fascicularis of the adrenal. The areas in which the cells appear to be in acinar arrangement are probably due to a tubular-like placement, cut in cross-section, or a centralized liquefaction necrosis. The precocious development of the genitalia is in accord with adrenal tumors.

TUMOR OF THE LIVER OF ADRENAL ORIGIN

DR. JAMES B. MASON and DR. JOHN SPEESE reported the case of a white boy of seventeen months, who was admitted in the service of Dr. John H. Gittings, at the Children's Hospital, February 2, 1926, with the chief complaint of severe upper abdominal pain, and high fever (103° F.). These symptoms had developed suddenly one week before admission, and with but slight remissions had persisted. There was no vomiting or diarrhœa. There was a negative family history and the past medical history was without incident except for an episode of acute gastro-enteritis in November, 1925. The infant was very anæmic. The abdomen was distended and showed an area of ecchymoses about the umbilicus. Palpation revealed a hard, irregular, tender mass in the left hypochondrium, which did not move with respiration, was not continuous with the spleen, and which extended downward and laterally apparently toward the left kidney.

There was a negative urinalysis. The blood studies showed a marked secondary anæmia. The blood Wassermann was negative. Three days after admission a transfusion of 175 cubic centimetres of citrated blood was given. Five days after admission the leucocytes were 18,900, and the hæmoglobin had decreased to 26 per cent. and erythrocytes were 2,510,000. One week after admission the patient was transferred to the surgical service of Dr. John Speese.

February 9, 1926, Doctor Speese performed a laparotomy. A vascular tumor the size of a large orange was discovered attached to the under surface of the right lobe

TUMOR OF THE LIVER OF ADRENAL ORIGIN

of the liver, just to the right of the mid-line. The tumor was encapsulated and was removed with ease. Further exploration revealed no other abnormalities. Immediately after operation the patient was given a transfusion of 115 cubic centimetres of citrated blood. Except for a mild pulmonary complication the convalescence was without incident and the patient was dismissed on the fourteenth post-operative day.

The tumor was an orange-sized fibrotic, vascular tumor, which cut without gritty sensation and which exuded blood from the cut surfaces. In none of the sections of the tumor were liver cells or bile passages demonstrable. There were frequent areas of hæmorrhage and of degenerative changes following hæmorrhage, with overgrowth of fibrous tissue, and presence of hæmosiderin. Indeed, it was a gross hæmorrhage into the tumor which provoked the acute symptoms. However, there were present in the tissue three distinct areas, with as many different histological pictures. There were groups of highly vacuolated cells in irregular cord formation, similar in size, arrangement, and inner structure to those of the Zona Fasciculata of the adrenal gland. The second type of cytology was represented by nests of basophilic staining cells, similar in appearance to the cells found in the Zona Glomerulosa of the adrenal. The third type of abnormal structure found in this tissue was acini-like areas mostly without cell lining, sometimes, however, lined by cuboidal cells in a single layer, while in other areas the lining was of many layers. The majority of these acini were filled with eosin staining colloid or hyaline material. They did not resemble thyroid acini or acini of any particular organ. Also, there were numerous areas of this hyaline-like material which greatly resembled decalcified bone in appearance. On careful study it became apparent that the hyaline-like material could be observed in which one could faintly distinguish outlines of erythrocytes. Although there were occasional mitotic figures present, complete differentiation of the cellular elements suggested a benign tumor or one of very low-grade malignancy. The result of this histopathological study revealed that a primary tumor of the liver of adrenal rest origin, either benign or of very slight degree of malignancy, had been encountered.

The child was under observation for seven months after operation, and gave no evidence, either clinical or by X-ray, of recurrence or metastases. The patient was not seen in the medical dispensary until January 3, 1931, when he returned because of a three months' history of a harsh, deep voice, and progressive symptoms of sexual precocity. He presented enlargement of the bones of the face and the extremities. There was a considerable growth of pubic hair and the genitalia were much over-developed. He weighed seventy-one pounds. He was admitted to the hospital on Doctor Speese's service for further study. Urinalysis was negative. Blood count was normal and blood-chemistry studies were within normal limits. The blood serology was negative. X-ray studies were negative for metastases to the long bones or spine. The skull showed a small sella turcica, and a marked density in the right antral region. The patient was dismissed with a diagnosis of hypernephroma, unimproved.

He developed chickenpox in March, 1931, and two weeks later was admitted to the Temple University Hospital with a chief complaint of marked pains in the back and all four extremities. X-ray examination revealed a small sella turcica, right maxillary antrum filled with soft tissue material, and no evidence of a pineal tumor. The child was admitted to Tumor Clinic of the Jewish Hospital, May 18, 1931. Metastatic lesions were found in the spine, left lung, ileum, and right femur. The conclusion was that the multiple bony metastases and the chest metastasis were from a malignant neoplasm, probably hypernephroma.

The right nasal cavity was occluded by a hard growth, which extended towards the infraorbital region. While in the hospital the child ran a very irregular temperature, varying from 108° F. to 96° F. Analyses of urine and blood, except for moderate secondary anæmia, were not abnormal. The child grew progressively worse and died June 6, 1931. Post-mortem was not permitted. A final diagnosis of hypernephroma with metastases to bone was made.

The reporter referred to a paper by Doctor Bothe in 1926, in which were discussed theories of adrenal rests and tumor formation. In a study on the sixteen-millimetre human embryo, he noted the juxta-position of the anlagal cells of the suprarenal with the primitive cell masses of the liver, kidney, ovary, testicle, epididymis and uterus. He concluded that "one can easily see the possibility of adrenal inclusions in any of these organs." Bothe further presented evidence that primary hypernephroma may develop in any tissue or organ which is the seat of adrenal rests, and he tabulated cases of primary hypernephroma of the liver by Adami and McCrae, Rolleston, Schmorl, Vecchi and Noyes. Recent case reports by Abell and Ramsey give further evidence to his contention for this organ. When hypernephroma occurs in children sexual precocity is frequently encountered. Goldzieher drew attention to this phenomenon in young girls, and pointed out that cortical adrenal hyperplasia, or the presence of adrenal tumors or hypernephroma, were the causative factors. In boys he believed that pineal tumors, or testicular teratomas were responsible for sexual precocity in more instances than were adrenal tumors. There are numerous case reports in the recent literature by Schweizer, *et al.*, Orru, Harris and Plewes, and Ismail, who present cases of sexual precocity in children, due to suprarenal tumors in one locality or another. That sexual precocity does not develop in all instances of adrenal tumors, testicular teratomas or pineal tumors, Goldzieher stated in explanation that many of these tumors are rapidly growing, and that the patient succumbs to the malady before the anatomical changes incident to sexual precocity have had an opportunity to develop. In this case, it is apparent that the pathological phenomenon which brought the patient to the hospital, and allowed the surgeon to discover a neoplasm of the liver, was the occurrence of a hæmorrhage into the tumor, with the production of pain and fever. That the primary tumor was of adrenal origin rests upon a sound cytological basis, but that it was truly benign or of a low grade of malignancy is less definite. The complete differentiation of cells of the tumor, the presence of a capsule, and the period of nearly five years of good health speaks for benign neoplasm. The question naturally presents itself—was death due to a slow-growing remnant of the primary tumor or was there an independent recent growth of greater malignancy—probably hypernephroma? It is suggested that this latter opinion is likely correct.

BIBLIOGRAPHY

- Abell, I.: Primary Hypernephroma of the Liver. *ANNALS OF SURGERY*, vol. lxxxvii, pp. 829-836, 1928.
- Bothe, A. E.: Hypernephromata. *ANNALS OF SURGERY*, vol. lxxxiv, pp. 57-88, 1926.
- Goldzieher, M. A.: *The Adrenals*. MacMillan, New York, pp. 280-285, 1929.
- Harris, G. W., and Plewes, D. F.: Hypernephroma with Virilism in a Child of Three, *Canad. Med. Assn. Jour.*, vol. xxiii, pp. 244-246, 1930.
- Ismail, K.: Suprarenal Tumors Causing Hirsutism. *Presse Med.*, vol. xxx, pp. 302-303, 1930.
- Orru, M.: Virilism in Suprarenal Tumors. *Folia gynaec.*, vol. xxviii, p. 143, 1931.

TUMOR OF THE LIVER OF ADRENAL ORIGIN

- Ramsey, T. L.: Primary Hypernephroma of the Liver. *ANNALS OF SURGERY*, vol. xc, pp. 41-46, 1929.
- Schweizer, F.: Senet, O., and Llambias, A.: Suprarenal Tumor with Adiposity, Hypertrichosis and Macrogenitosomia in a Seven-Year-Old Girl. *Arch. argent. de pediat.*, vol. i, pp. 550-556, 1930.

DR. RALPH S. BROMER, by invitation, remarked that metastases in hypernephroma are more usually of the hypoplastic type and not of the hyperplastic type, as in this case. Here the periosteum seems to be raised up but there are no perpendicular striations so often seen in malignant lesions of bone. The appearance is more like that of the lace-work type of periosteal change observed in syphilis of bone. From the röntgenograms alone, without knowing the history of the case, it would be impossible to make a diagnosis. Several years ago, in a case of neurocytoma primarily located in the adrenal, observed at St. Christopher's Hospital for Children, metastatic lesions in the long bones were found, but, although they were hyperplastic in type and seemed to affect the periosteum for the most part, yet typical perpendicular striations were present. The shadow in the mediastinum in the chest films of this case, apparently due to metastasis, very much resembles a mediastinal mass of tuberculous glands. The changes in the vertebral bodies, wedge-shaped deformities, but with complete preservation of the intervertebral spaces, would rule out tuberculosis as a cause of the osseous lesions. The presence of the hyperplastic type of metastasis in this case of adrenal tumor and also in the neurocytoma just mentioned, seems to suggest that in adrenal tumors of childhood the prevailing type of metastasis is hyperplastic in character, while in cases of hypernephroma in adults, the opposite seems to be the more usual finding.

DR. WALTER E. LEE said that the association of precocious sexual development in patients with adrenal tumors has recently been reported from a number of clinics in this country. There are two rather unusual cases in Philadelphia at the present time. The one at the Germantown Hospital, under the care of Doctor Swartley, is thirty-five years of age. She has been married nine years as a wife but she anatomically is male. The other, at the Pennsylvania Hospital, is fourteen years of age with all the characteristics of a boy, with the hair so well developed that it is necessary to shave three times a week. The voice is a deep bass. The external genitalia are abnormal. There is a clitoris which is large enough to be mistaken for a penis, the hymen is imperforate and there has been some suggestion of menstruation. This patient was operated upon because on rectal examination a tumor in the pelvis was thought to be an enlarged ovary. On examination, perfectly normal female pelvic organs were found, uterus, tubes and ovaries. The kidneys were palpated but apparently were in normal position and of normal size and there was no enlargement of the upper pole suggesting tumors of either adrenals.

BLADDER INJURY FOLLOWING WOUNDS IN THE THIGH

DR. ALEXANDER RANDALL reported the case of a man aged thirty-three, who, while hunting on December 5, 1931, was in a crouching position, ready to shoot, when a stranger fired in his direction. They both were stalking the same deer from different approaches. Immediately following the report of this gun he felt an impact on the outer middle third of the left thigh. Having been wounded in the opposite leg, during the last war, he realized that he had been shot; but soon finding that his locomotion was not involved, nor any pain experienced, he made his way back to his companions, and from thence to his home. The wound of entrance was found, but there was no evidence of hæmorrhage or foreign body, and a simple dressing was followed by a prompt primary union. An X-ray failed to show the missile in the leg, but a picture of the pelvis depicted it in what was thought to be the muscles of the buttocks. A few days later, experiencing increasing difficulty at urination, but without having observed the slightest amount of hæmaturia, he was cystoscoped and a round ball was seen to be lying free in the bladder cavity. There was a slight amount of ecchymosis on the left lateral wall, but without evidence of perforation or any urinary extravasation. January 6, 1932, with a cystoscopical rongeur, it was possible to grasp the foreign body and withdraw it through the urethra in the beak of the instrument. When examined it was found to be slightly encrusted with phosphatic salts and to be a caribou buckshot. The patient's recovery was uncomplicated.

The only inconvenience that this foreign body created in the bladder, which it unquestionably entered at the time of the original wounding, was the blockage of the internal vesical orifice at urination. At the time of the removal of the buckshot, the only evidence at the point of entrance into the bladder was a punctate scar on the left lateral wall about three to four centimetres above the ureteral orifice. There was still one slight ecchymotic spot visible.

TRAUMATIC PERFORATION OF URINARY BLADDER WITH RETENTION OF WOOD SPLINTERS

DOCTOR RANDALL reported the case of a boy aged eleven, who was admitted to the hospital May 4, 1929. Five years before, the patient fell off a porch into a hedge and fencing, at which time a splinter of wood entered the left thigh on the inner aspect of the lower third. An attending physician pulled out a long splinter of wood and applied a local dressing, and three days later the infected wound required hospitalization and dressings. One month after the accident, an abscess formed in the region of Scarpa's triangle. This was incised and pus and urine evacuated. Following this incision, urine continued to dribble from this fistulous orifice. The patient was then cystoscoped and a rent observed in the left side of the bladder. A cystotomy was performed and the wound in the left lateral wall of the bladder sutured. Following this the fistula in the thigh closed for a month and normal urination was temporarily established. Then the abdominal incision broke down and became a urinary fistula. Six months later, the fistula in the thigh likewise reappeared. During the past five years urine has passed through both fistulous orifices and the urethra, while the boy has been of necessity kept from school, play and his normal activities.

Study of this case, five years after the accident, revealed the following condition: There was a patent suprapubic fistula discharging urine, and a second urinary fistula over Scarpa's triangle; the course of the wood splinter from the point of entrance to the fistula in the thigh had apparently been healed a number of years. Mild urinary sepsis existed, though the blood urea never exceeded thirteen milligrams to the 100 cubic centimetres. Study by cystograms failed to show any extravasation from the bladder, though marked regurgitation up the urinary tract occurred. There appeared to be a complete breakdown of the uretero-vesical sphincters with marked dilatation of both ureters and renal pelves. Cystoscopy revealed an unhealthy scar in the left lateral

SALIVARY CALCULI

bladder wall. Injection of the fistula in the thigh, followed by stereoscopic plates, demonstrated beyond question that the fistulous tract led through the obturator foramen and the injected material appeared not only in the bladder but again regurgitated up either ureter. Operation, May 20, 1929, found a small contracted bladder with an ulcerated orifice on the left lateral wall leading out into the cellular tissues in the left side of the pelvis. A probe passed into the thigh fistula found its way into this ulcerated bladder lesion. Extravesical exposure led down to an unhealthy cavity from which *four large splinters of wood*, still retaining their green paint, were removed. They were of similar length, measuring 7 centimetres and varied in thickness from that of a match stick to four times this size. The sinus was thoroughly curetted and a rubber tube and gauze pack placed from the fistulous opening in the thigh to the peri-vesical area. The wall of the bladder was freshened about its borders and closed with interrupted catgut sutures. The bladder was closed about a mushroom catheter drain. The patient made a slow recovery from this operation, and on June 3, 1929, the thigh fistula appeared to be healed, and on June 25, 1929, a bladder examination, obtained by passing the cystoscope into the suprapubic fistula, apparently showed the bladder wall likewise healed. Drainage was then removed from the suprapubic fistula, and the same allowed to heal. Incontinence developed with the closure of the sinus and though the patient appeared to have voluntary control of bladder emptying, nocturnal incontinence was the rule. With this development, both suprapubic and thigh fistulæ again opened spontaneously on July 3, 1929. The suprapubic wound was opened and a débridement of the fistulous tract to the thigh, followed by a tight gauze pack, was performed. On August 23 he was discharged, in care of his physician, with a permanent suprapubic mushroom catheter. With the continued closure and apparent permanent healing of the thigh fistula, his suprapubic tube was removed during the middle of December, 1929, and the patient reported for observation January 26, 1930. His thigh fistula appeared strongly healed, while the suprapubic one was rapidly closing. A cystoscopical examination January 29, 1930, showed a small bladder with a healthy mucous membrane and a healthy scar on the left lateral wall. Both ureteral orifices were visualized and found to be gaping open. The suprapubic fistula was severely curetted and cauterized with the intention of allowing it to heal. During this stay in the hospital, two studies by means of uroselectan were performed. They both showed a bilateral hydronephrosis and hydroureter, in spite of which a blood-urea estimation of eighteen milligrams was recorded, and a phthalein output of 40 per cent. February 12, 1930, his suprapubic fistula closed and normal voiding was obtained at two- to three-hour intervals by day, though at night incontinence was the rule. He was discharged on March 16, 1930. He was re-admitted to the hospital June 13, 1931, at which time his suprapubic wound was reported as being well healed. A Caulk's cautery punch operation was performed with the idea of correcting a congenital stenosis of the internal sphincter as a possible cause of persistent back pressure on the bladder and upper urinary tract. This operation was performed June 17, 1931, and his recovery was uncomplicated; since which time a follow-up examination September 12, 1931, showed both fistulæ to remain permanently healed, and though the child has normal voluntary urinary control by day, nocturnal incontinence is still troublesome. Final observation on the patient, the first week of March, 1932, showed both fistulæ to be strongly healed, and there has been no leakage since the last report. He has grown in strength and is attending school, though probably slightly under size for his age.

SALIVARY CALCULI

DRS. ROBERT H. IVY and LAWRENCE CURTIS read a paper, Salivary Calculi, for which see ANNALS OF SURGERY, December, 1932, p. 979.

MEMOIRS

WILLY MEYER, M.D.

1858-1932

WILLY MEYER was born at Minden, Germany, July 24, 1858. He studied at Bonn, then at Erlangen, and in 1880 took his M.D. at Bonn. After a military service as voluntary surgeon he became Assistant in the Surgical Clinic



WILLY MEYER, M.D.

of the University of Bonn, which position he held for three years, in the last of which he was First Assistant.

Trendelenburg was then Chief of the Clinic. Young Meyer assisted him in many operations during those years in which the method of elevating the patient's pelvis in the performance of certain pelvic and abdominal operations was worked out and thoroughly tested by Trendelenburg, who, in 1884, entrusted to Meyer the first publication of that posture which subsequently became universally known as Trendelenburg's posture. A friendship developed between the two men which lasted up to Trendelenburg's death.

Doctor Meyer came to New York in 1884. Two years later he was appointed Professor of Clinical Surgery at the Woman's Medical School, Attending Surgeon to the New York Skin and Cancer Hospital and to the German Hospital, now known as the Lenox Hill Hospital, and in 1887 to the Post-Graduate Hospital.

In 1923, having reached the age limit, he continued his connection with these institutions in the capacity of Consulting Surgeon. The New York Infirmary for Women and Children, the Hospital for Joint Diseases, the Montefiore and the Glens Falls Hospitals also had him on their Consulting Staffs for many years.

He introduced into this country the results of investigations by a number of European physicians, thus cystoscopy in 1887, catheterization of the ureters in the male in 1896, Bottini's operation for hypertrophy of the prostate gland in 1897, and modern methods of gastrostomy in 1894 to 1896.

Thoracic surgery became one of his favorite studies in 1904, with especial attention to the negative-pressure cabinet introduced by Mikulicz and Sauerbruch. After experimental studies with a cabinet at the Rockefeller Institute he caused a most perfect cabinet and outfit for all varieties of differential pressure to be constructed at the German Hospital, which was doubtless the finest plant of this nature in existence. Thoracic surgery in America owes a great deal to Meyer's pioneer work. In his clear vision of the importance of this specialty he founded in 1919 the New York Society for Thoracic Surgery and the American Association for Thoracic Surgery.

In 1894, after Heidenhain had shown that in carcinoma of the breast an involvement of the pectoral muscles was very common, he studied this phase with intense interest, elaborating and improving the then existing methods of operation, and published his method of a more radical operation for cancer of the breast, a method with which his name is connected in the literature on that subject. His interest in cancer and his extensive study of the literature on cancer are best evidenced in his last publication, a book entitled "Cancer," in which he comes to the conclusion that cancer is a systemic disease.

Among his publications, those on thoracic surgery are probably the most numerous, but he has been a prolific writer on many other subjects.

He was a Fellow of the American College of Surgeons, a member of the American Medical Association, American Surgical Association, American Thoracic, Gastro-Enterological and Urological Associations, American Association for Cancer Research, New York County and State Medical Societies,

WILLY MEYER

New York Academy of Medicine, New York Surgical Society, Pathological Society, Deutsche Gesellschaft für Chirurgie, and Deutsche Gesellschaft für Urologie.

Not satisfied with the performance of routine surgery, he was an ardent student of medical literature and was eager to grasp and accept anything that impressed him as being a valuable addition or improvement in surgical procedure. His enthusiastic advocacy of what he considered good and worth while was always inspiring and often convincing.

He loved to teach, and many house staff members who worked under him appreciate how much they owe to the instruction received from Doctor Meyer as he entered into discussions with them on the minutest details in any case under his treatment.

He will always be remembered as a sincere seeker for truth in medical science and as a diligent worker in its propagation. In the furthering of any task he had undertaken he was often referred to by his friends as being a "live wire," on account of the great energy he displayed. This devotion to a purpose served as a stimulus to many who had the good fortune to observe his work. Through his personal charm he made many friends, and through his earnest efforts in the cause of medical science he gained universal respect.

He had the good fortune to work in his chosen path to the very last hour, for, when he died, February 24, 1932, it was shortly after the end of a meeting of the New York Surgical Society, at which he had taken part in a discussion on cancer of the breast.

FRANZ TOREK

EMORY GRAHAM ALEXANDER, M.D.

1880-1930

EMORY ALEXANDER died in Philadelphia on August 29, 1930. He was born in Charlotte, North Carolina, in 1880. He received his preliminary education at the University of North Carolina and graduated from the Jefferson Medical College in 1904. His ancestors, both the Alexanders and Grahams, have been conspicuous in the history of the country since Colonial



EMORY GRAHAM ALEXANDER, M.D.

days. On graduation Doctor Alexander became an intern at the Episcopal Hospital of Philadelphia. On completing his service, he took up the teaching and practice of surgery. He was closely associated with Dr. H. C. Deaver, one of the surgeons of the Episcopal Hospital. Among his subsequent teaching positions were: Demonstrator of Fracture Dressings at the Jefferson Medical College; Clinical Professor of Surgery, Women's Medical College, and Clinical Professor of Surgery at the University of Pennsylvania.

EMORY ALEXANDER

The last position, and that of Attending Surgeon of the Episcopal Hospital, he held at the time of his death.

In addition to his Fellowship of the American Surgical Association, he was a Fellow of the Philadelphia Academy of Surgery, of the College of Physicians of Philadelphia and of the American College of Surgery.

Doctor Alexander made numerous contributions to surgical literature usually through the medium of the Academy of Surgery.

During the late war he served as one of the surgeons of a Base Hospital in France with the rank of Major.

Doctor Alexander's success, which began at an early period in his professional career, was due to his skill, his judgment and his enthusiasm.

Doctor Alexander married the daughter of Dr. John B. Deaver, who survives him.

JOHN H. GIBBON.

PHILADELPHIA, PA.

EDITORIAL ADDRESS

The office of the Editor of the Annals of Surgery is located at 386 Park Street, Upper Montclair, New Jersey. All contributions for publication, Books for Review, and Exchanges should be sent to this address.

Remittances for Subscriptions and Advertising and all business communications should be addressed to the

ANNALS OF SURGERY
227-231 South Sixth Street
Philadelphia, Penna.

ANNALS *of* SURGERY

Vol. XCVII

FEBRUARY, 1933

No. 2

TREATMENT OF FRACTURES IN THE CINCINNATI GENERAL HOSPITAL

By JOHN A. CALDWELL, M.D.
OF CINCINNATI, OHIO

FROM THE SURGICAL DEPARTMENT OF THE COLLEGE OF MEDICINE OF THE UNIVERSITY OF CINCINNATI

THE fracture service of the Cincinnati General Hospital is controlled by the Department of General Surgery and is under the direction of an associate Clinical Professor of Surgery. He is assisted by the resident and assistant resident surgeons, all of whom are members of the Graduate School of Surgery. One of the latter serves on the fracture service exclusively for a period of six months, during which time he has direct supervision and care of all patients with fractures. He is assisted by an interne on each ward whose work, however, is not confined to fractures. In the absence of the director or other members of our surgical staff, this assistant resident has available for consultation the chief resident surgeon, who has previously had a term in the fracture service, as well as other assistant residents who have completed their fracture service.

This arrangement places all of the care of broken bones under one responsible head—a system which has both advantages and drawbacks but which definitely fixes responsibility. This plan, with but slight modification, has been employed for ten years. It is the purpose of this paper to describe some methods, procedures and apparatus which have gradually evolved in this period of time rather than to give tabulated series of cases and results.

Following list shows the fractures which were admitted to the hospital during one year and it may be considered fairly typical for each year. It does not include ambulatory cases which were treated in the dispensary and not admitted to the wards. The minor fractures enumerated were associated with more serious injuries which made hospitalization of the patient necessary.

| | | | |
|----------------------------|-----|-------------------------|-----|
| Skull | 255 | neck | 15 |
| Mandible and maxilla | 41 | intertrochanteric | 14 |
| Clavicle | 21 | sub-trochanteric | 14 |
| Scapula | 3 | condyles | 3 |
| Metacarpal | 6 | trochanter only | 2 |
| Metatarsal | 12 | pathological | 1 |
| Os calcis | 8 | Tibia and fibula | 137 |
| Zygoma | 2 | Pott's fracture | 20 |
| Nasal bones | 3 | Patella | 7 |
| Femur-shaft—adult | 36 | Olecranon | 10 |
| shaft—children | 23 | Vertebrae | 32 |

| | | | |
|---|----|---------------------------------------|-----|
| Ribs without serious respiratory symptoms | 46 | Colles fracture | 40 |
| Crushed chest | 21 | Dislocations | 9 |
| Pelvis | 35 | Multiple fractures unclassified | 2 |
| Humerus | 63 | Traumatic amputations | 26 |
| Radius and ulna | 26 | Total number of fractures | 933 |
| | | Total number of patients | 804 |

Anæsthesia.—For general anæsthesia, our preference is for ether, although gas and chloroform are occasionally used when the period of anæsthesia is to be short or there are other special indications.

For reductions alone we have become strong advocates of the use of local anæsthesia after the manner popularized by Böhler.³ The points to be

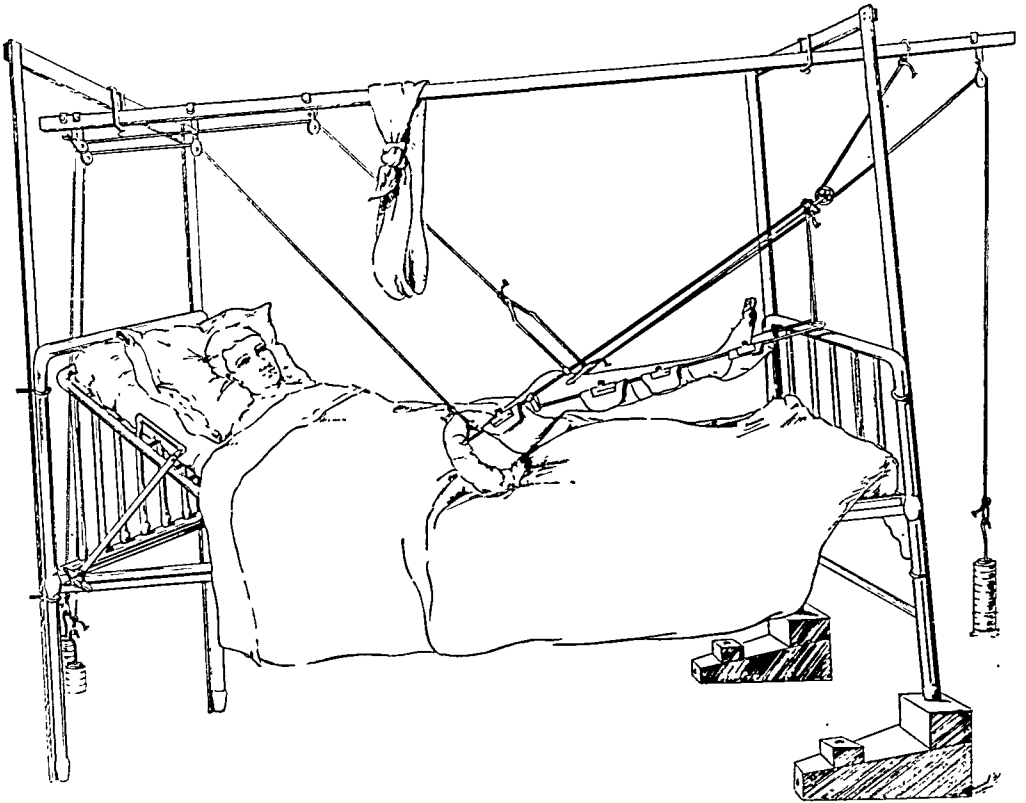


FIG. 1.—Illustration of the usual method of treating fractures of the shaft of the femur—a Thomas splint with the Pearson attachment. The Steinman pin is inserted through the head of the tibia, but when there is special reason it is occasionally passed through the lower end of the femur.

emphasized for success in rendering the manipulation of a fracture painless by means of local anæsthesia are: (1) The anæsthetic *must* be injected into the hæmatoma surrounding the ends of the bone so as to dilute the blood with the anæsthetic solution. To make sure that this requirement will be fulfilled, the piston is drawn back and no injection is made until pure blood appears in the syringe. When the needle is in the hæmatoma the solution may be injected with very little pressure. The injection of the solution outside of the hæmatoma is certain not to relieve the pain of the fracture during manipulation. (2) It is important to wait a sufficient period of time for the anæsthetic to take effect before any manipulation is made. Our practice is to wait ten minutes *by the clock* before the fragments are moved.

TREATMENT OF FRACTURES

Two per cent. procaine is used. For fractures of such bones as the humerus, radius or ulna, and tibia or fibula, ten cubic centimetres are usually sufficient; for the femur twenty cubic centimetres, or even forty cubic centimetres, may be necessary. These quantities are proportionately reduced in children. When there is a fracture of both bones of a limb, both fractures must be injected. Local anæsthesia has been used in about 900 fractures, and so far no infection has resulted from its use. One extremely useful application of local anæsthesia is its injection prior to transportation of a patient. This may be done in the home. The anæsthesia persists for one to two hours and thus lessens the pain and shock incident to moving the patient.

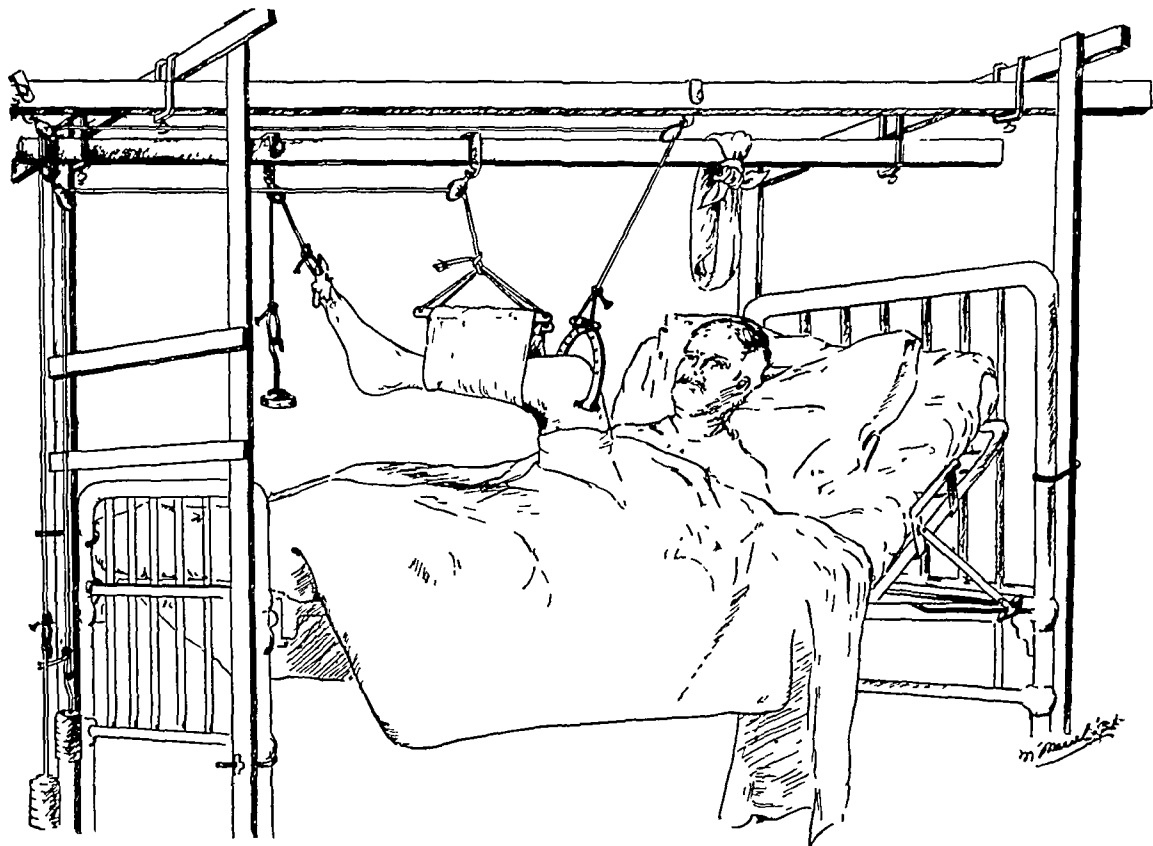


FIG. 2.—Suspension of the thigh at a right angle to the body in an oblique sub-trochanteric fracture of the femur when it is necessary to rotate the shaft of the femur outward to align it with the externally rotated upper fragment. Since the hamstring muscles are completely relaxed, the fragments may easily be pulled apart by too heavy weights.

Spinal anæsthesia is frequently employed in cases of fractures of the leg and so far there have not been any untoward sequelæ from its use. It is used in preference to local anæsthesia when it is necessary to carry out two or more painful procedures, as, for example, the manipulation of a fracture, the application of an apparatus and the insertion of a pin or ice tongs.

Brachial anæsthesia is used infrequently, and in our hands there is often a failure to secure satisfactory anæsthesia. This is possibly because we do not make use of the method often enough to become proficient in the technic of the injection.

Fractures of the Neck of the Femur and Intertrochanteric Fractures.—These fractures fall into two classes: (1) Those in which the general condi-

tion of the patients indicates the employment of ideal treatment; and (2) those in which general feebleness of the patients forbids ideal treatment.

For patients in the first class our preference is for the Whitman abduction treatment, occasionally preceded by an impaction of the fracture after the method of Cotton. Intertrochanteric fractures are often treated by Buck's extension or some form of balanced skin or skeletal traction. Several years ago we treated a series of seventeen cases of fractures of the neck of the femur by means of the Wilkie¹ spreader and were convinced that in patients so treated the fragments remain in position during all possible changes of position. The end-results were quite as satisfactory for securing union as by other methods. However, the patients were less comfortable because the

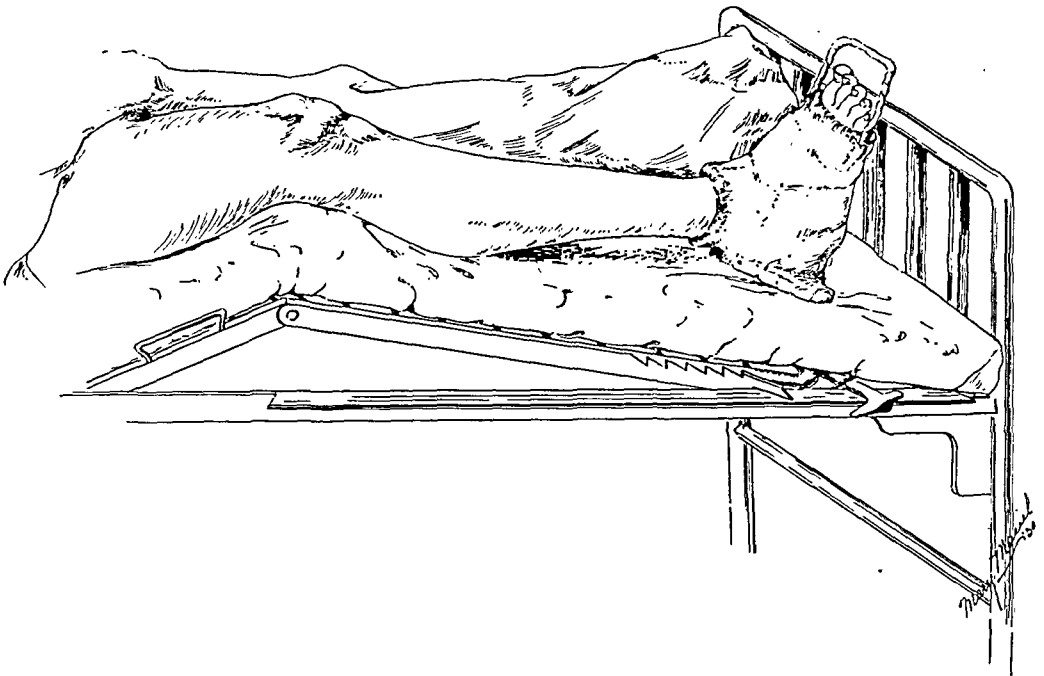


FIG. 3.—Illustration of the anti-eversion boot which is used instead of sand bags in the treatment of impacted fractures of the neck of the femur when a plaster case is inadvisable. A well-padded boot of plaster is applied and a cross bar of wood is incorporated so that the foot cannot rotate. The loop of wire extending above the toes keeps the bed clothes off the toes and obviates the troublesome bed cradle. This loop is put in all leg cases when the patient is confined to bed.

position was a straining one, and because the pressure of the plaster boots was often painful, and occasionally caused pressure sores. The nursing of the patients in spreaders was more troublesome. Since arriving at the above conclusion the Wilkie method has been reserved for these patients who, by reason of obesity or urinary incontinence, were not proper subjects on whom to apply a Whitman spica.

For patients in the second class, the treatment is modified as indicated by the general condition of the patient, and needs no special discussion. For reasons of age, general debility, pneumonia, shock, the treatment is often rest in bed with no appliances, the use of sand bags, or some simple form of extension.

Fractures of the Shaft of the Femur in Adults.—When the X-ray or

TREATMENT OF FRACTURES

fluoroscopical examination shows that the fracture is transverse and the chances of reduction favorable, we inject local anæsthesia, apply a Thomas splint and attempt to engage the fragments. If successful, the leg is laced firmly in the splint and left until the fragments are stuck by provisional callus. A spica of plaster is then applied. The proportion of successes in this form of treatment is not high. It must be remembered that fractures thus treated may slip and that frequent checks of the position of the fragments must be made by X-ray studies. When unsuccessful in maintaining reduction the leg is suspended under a Balkan frame in a Thomas splint. After accurately counterbalancing it and flexing the knee, traction is made by means of a Steinman pin through the head of the tibia. (Fig. 1.) We prefer

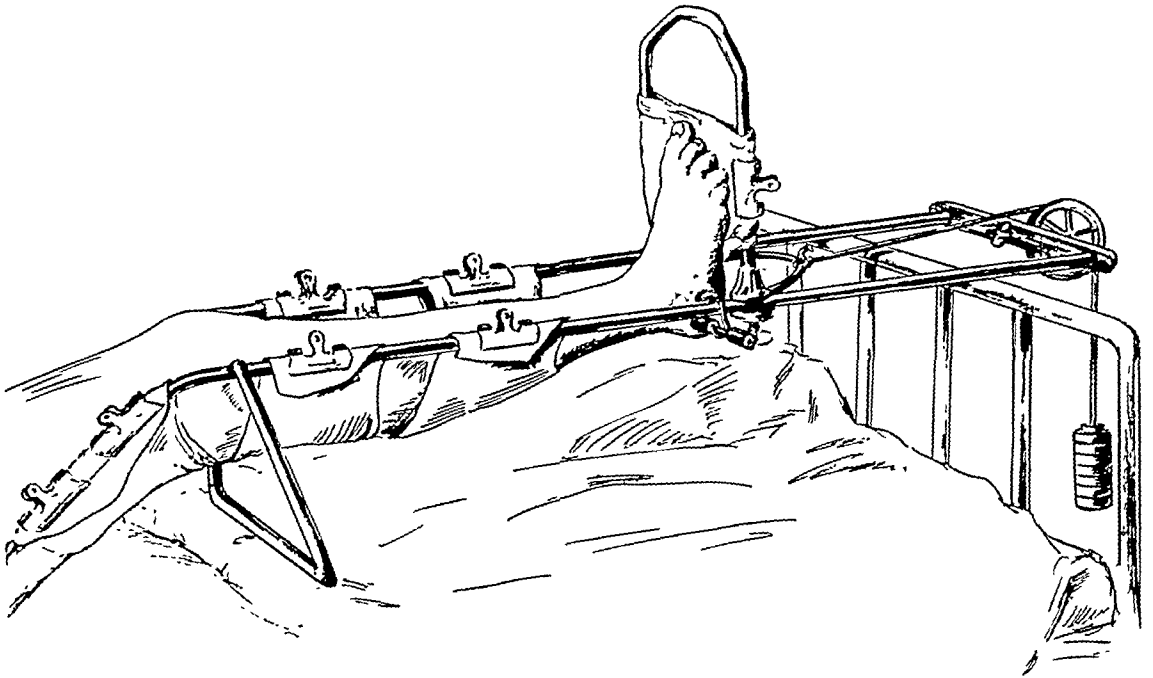


FIG. 4.—A simpler device which serves the purpose of the more cumbersome and expensive Braun frame. It is used for fractures of the tibia and fibula when traction is necessary. The pull is usually made on a pin through the os calcis, occasionally on ice tongs in the malleoli. By attaching another "croquet wicket" over the thigh this splint may be used as a Hodggen's suspension splint. (See also Fig. 10.)

to insert the pin through the tibia rather than above the femoral condyles, for we believe there is less danger of infecting the knee-joint or the fracture. Also, if traction is not successful and an open operation becomes necessary, the operative procedure does not have to be postponed or abandoned because of pin punctures near the field of operation. Occasionally, when the fracture is low in the femur, the pin must be inserted above the femoral condyles to correct the position of the lower fragment. In our experience with this fracture, it is just as well to perform an open operation early since it is inevitable in most instances.

One of the most troublesome fractures of the femur to treat is the oblique or comminuted sub-trochanteric break. We have had excellent results with a method of suspension and traction which we have not seen described elsewhere. A pin is inserted above the femoral condyle and the thigh is suspended at a right angle to the body, much as it is suspended in the Bryant method used for children. The knee is flexed to a right angle and the leg

is suspended by a sling to a different rail, and counterbalanced by a separate set of weights. By this apparatus the thigh can be rotated outward until the distal fragment comes into line with the externally rotated and flexed proximal fragment. With this arrangement the entire limb is suspended and counterbalanced; the patient's body makes the counter traction. He can shift or raise his body without disturbing the fragments. There is great danger in this method of pulling the fragments apart and seriously delaying union. In this flexed position of the leg, the hamstring muscles are quite relaxed and offer very little resistance to traction. We do not hesitate to use thirty or thirty-five pounds' pull on the ordinary fracture of the femur when the knee

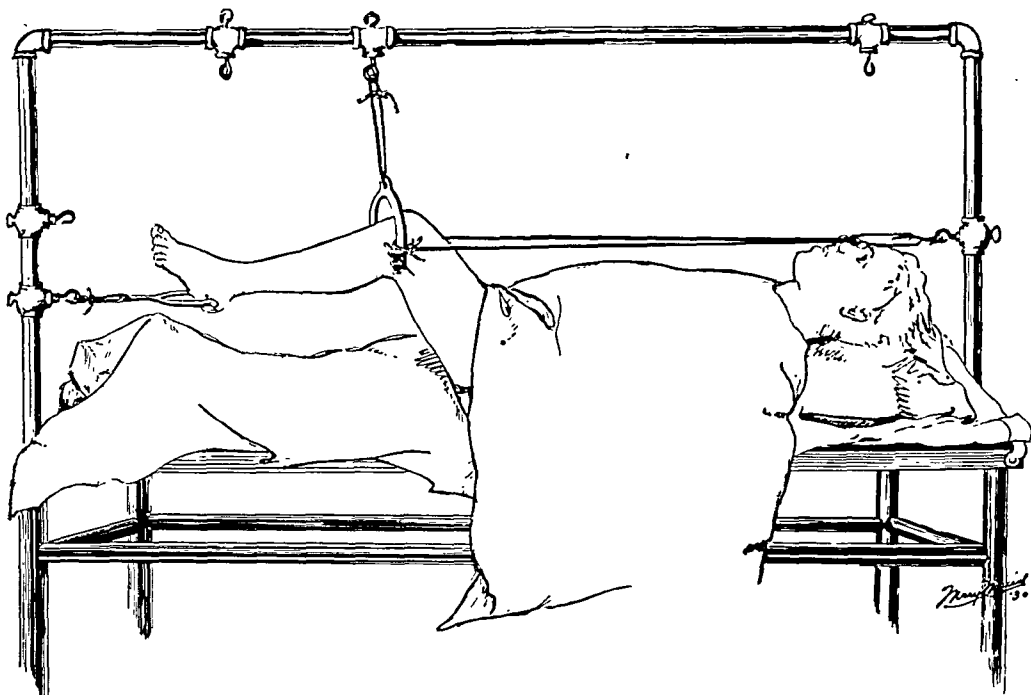


FIG. 5.—The leg is suspended in traction by an overhead rail attached to the fluoroscopical table and is ready for the application of a cast. The suspension and traction are upon pins or ice tongs which are removed as soon as the plaster is "set."

is semi-flexed, but, in the above method, when both thigh and knee are flexed to right angles, we ordinarily do not use more than fifteen to eighteen pounds. Even then the position of the fragments must frequently be checked with portable X-ray films. (Fig. 2.)

Fractures of the Femur in Children are suspended at a right angle after the manner of Bryant² in all suitable cases. If the uninjured thigh can be flexed to a right angle with the body without causing the knee to flex, the case is regarded as a proper one in which to carry out this method. In our experience this procedure can be used up to nine years, after which age children must be treated as are adults. Studies of end-results in our own patients, as well as others, have shown that good function results in these fractures in children in spite of extraordinary malposition of fragments. X-ray studies and measurements two or three years after union show almost unbelievable restitution of both length and contour.

TREATMENT OF FRACTURES

Open operations are performed in those fractures of the femur in which end-to-end approximation (not necessarily of the entire fractured surface) cannot be secured, or when interposition of muscle makes approximation impossible by closed methods. An endeavor is made to arrive at a decision concerning operation at the earliest possible moment. So far it has not been necessary to operate on the femur of a child under sixteen years of age. When open fixation is necessary our preference is for the Sherman plate and screws, although occasionally, when the break is very oblique, a Parham-Martin band is applied. The band is particularly suitable when the fracture is near the knee-joint. In this situation a plate is not satisfactory since the

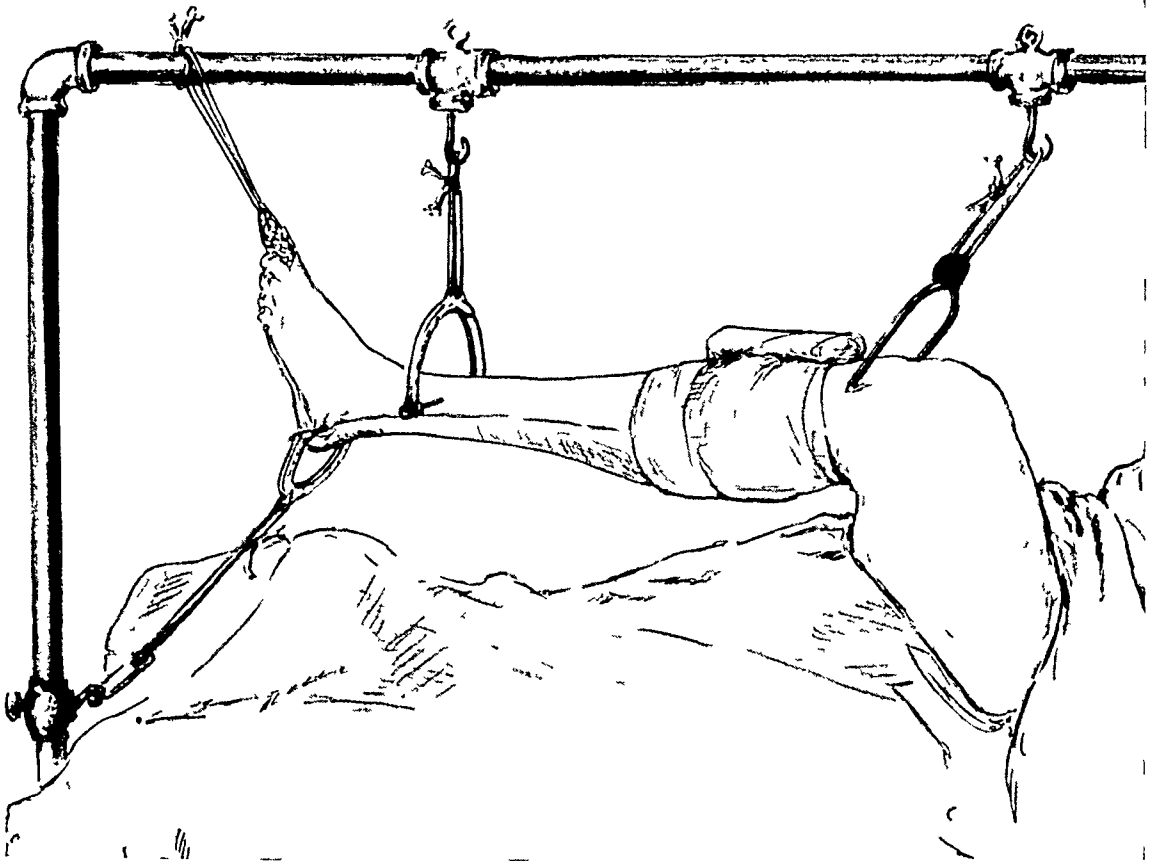


FIG. 6—A fracture of the os calcis is suspended and pulled into position after the fragments have been squeezed into place by the redresseur and is ready for the application of plaster. The pin and tongs are removed after the plaster is "set." Instead of the ice tongue or a pin below the knee a sling may be used about the thigh for counter-traction.

lower fragment is cancellous bone and screws do not hold well, and, if the break is very low, that portion of the plate which is applied to the lower fragment may be within the knee-joint, or at least may necessitate opening the knee-joint to apply it. After operation a plaster case is applied, or the leg is returned to the Thomas splint and suspended as before operation.

The Patella.—In fractures of the patella without separation of fragments, and when the power to extend the knee is retained, a Schanz dressing*

* I have been unable to find a description of the original Schanz dressing. The dressing to which we apply the name *Schanz* is as follows: The leg is wrapped from ankle to mid-thigh with two layers of sheet wadding, such as is used under a plaster bandage,—with as much tension as the texture of the material will allow. This is covered with

is applied for one week and the joint is aspirated whenever it becomes distended with blood. After one week a case is applied with the leg extended and the patient is allowed up on crutches. When the X-ray shows the fragments separated and the power of extension of the knee is lost, the case is considered as an emergency and an operation is done at once. The capsule of the patella is closed with mattress sutures of catgut, and the patella is surrounded with a loop of the same material. All shreds are carefully cut off, and the rents in the lateral expansions of the quadriceps tendon are accurately closed. A plaster bandage is then applied with the leg in extension. The operating is done through a transverse incision. Only one infection has followed an operation on the patella, and that was one in the case of an extensive compounded fracture.

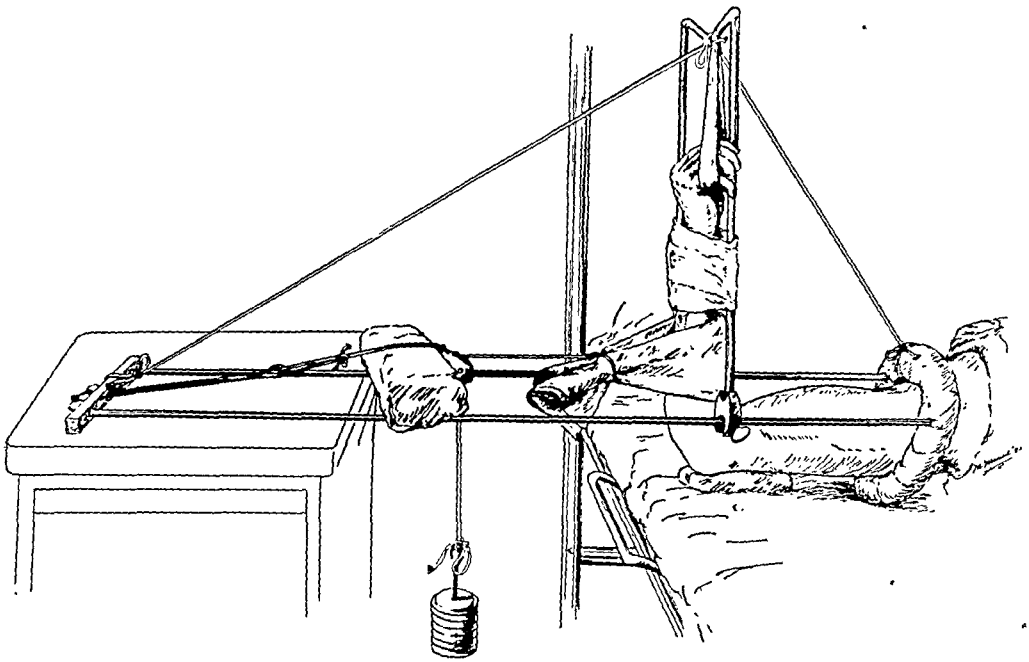


FIG. 7.—A method of applying traction in cases of fracture of the neck of the humerus. The traction is made with a Thomas knee splint and a Pearson attachment. The pull may be made upon a pin through the olecranon or a wire through the condyles instead of a sling about the forearm.

Fractures of the Tibia and Fibula.—An injury which has been encountered quite frequently has been called the “bumper fracture.” The victim sustains a blow by an automobile bumper on the outer side of the knee, which causes a comminuted crushing fracture of the head of the fibula and the outer condyle of the tibia. The force of the impact bends the knee laterally, tearing or stretching the internal lateral ligament. The knee-joint immediately distends with blood, and on manipulation lateral motion is marked. These injuries are treated by the application of a dressing and aspiration of the knee-joint, followed by a plaster case which is worn for six weeks. In two

turns of muslin bandage drawn quite tight. Two more layers of sheet wadding are then applied over the muslin bandage and a second muslin bandage is applied firmly over this second layer of sheet wadding. This makes a dressing which exerts uniform pressure over the surface and, on account of its bulk and stiffness, has considerable immobilizing effect.

TREATMENT OF FRACTURES

cases where the outer condyle had been greatly displaced, it was replaced by an open operation and held in place by a bolt through the head of the tibia. Weight-bearing is forbidden for six weeks after removal of the case. There has been no case of serious restriction of range of motion of the knee-joint from this prolonged fixation, but in three cases we have seen a more serious sequel. Because of impaired blood supply, or some other reason, the damaged condyle in these cases was gradually eroded and the opposing condyle of the femur was deprived of a bearing surface; the weight was then thrown

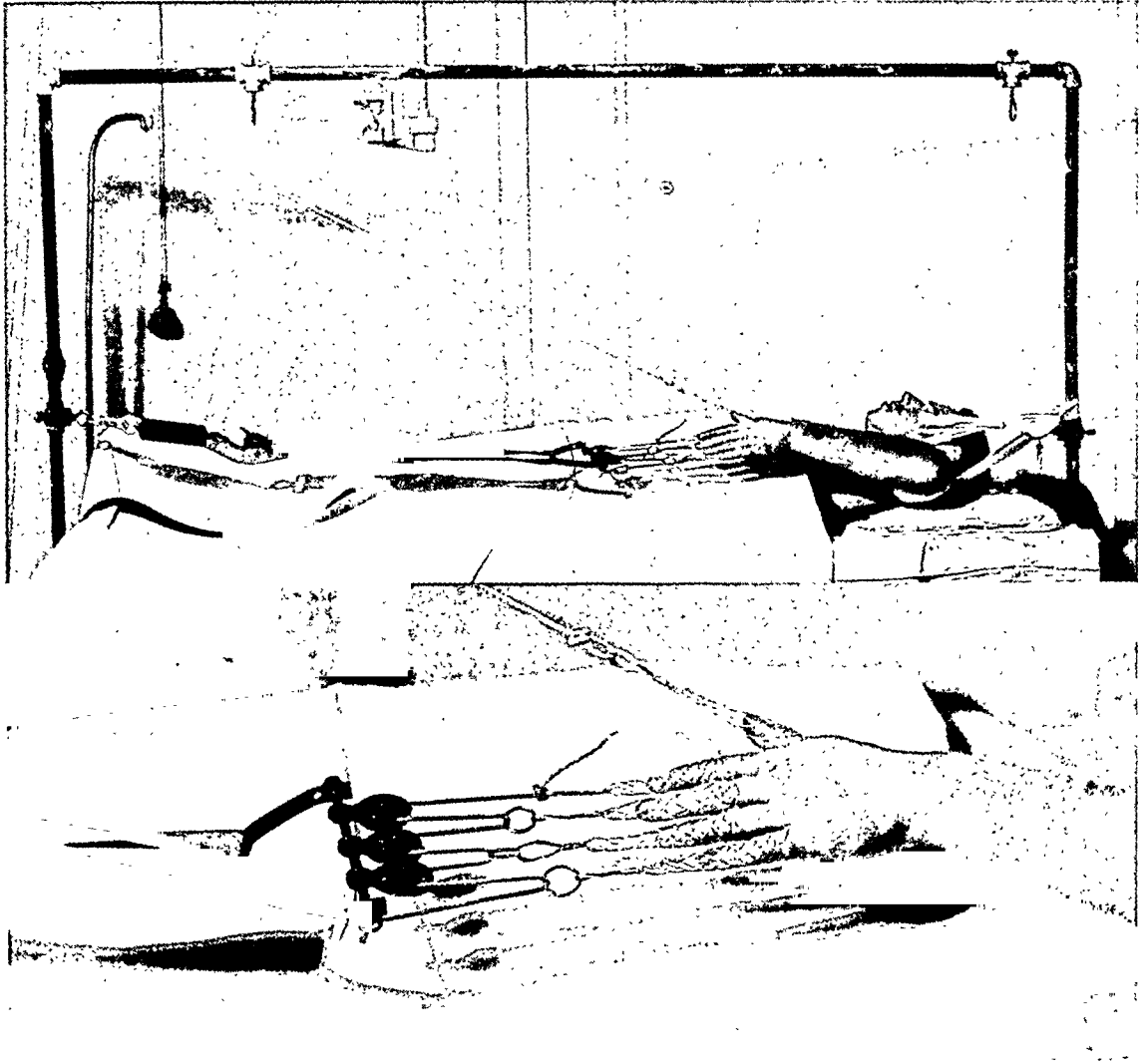


FIG. 8.—The forearm is suspended and pulled by means of "finger traps," and is ready for the application of plaster. This apparatus is used in fractures of the radius and ulna and Colles fracture.

entirely on the inner condyle. As a result a gradually increasing genu valgum was produced which finally required the patients to use braces. We know of no way of avoiding this complication except by prolonged restriction of motion and abstinence from weight-bearing.

Fractures of the shaft of the tibia and fibula, when transverse, are reduced under local or spinal anæsthesia and then fixed in plaster at once. (Fig. 5.) Any leg which is wholly encased is elevated at least 30° . The case is promptly removed if the toes show any impairment of circulation. When reduction

is accurate early swelling is apt to subside rather than progress although this is not universally true.

Pott's fractures are usually reduced under spinal or general anæsthesia and a circular plaster bandage or Stimson's dressing is applied at once. This fracture is put up in the position of ease and rest—that is, the foot is neither everted nor inverted and is at little more than a right angle with the leg. Occasionally the break is of such type that strong inversion is necessary to maintain position and, in such cases, the foot is placed in the inverted position but is changed to the more normal and comfortable position in ten to

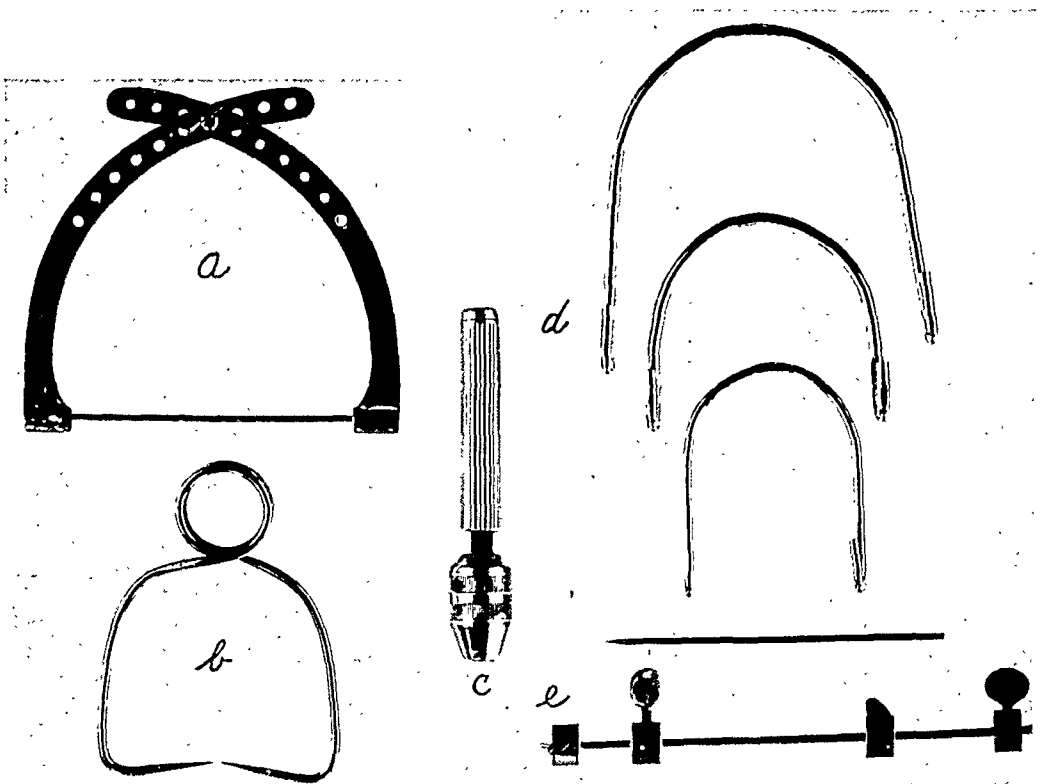


FIG. 9.—The usual contrivances used for skeletal traction. (a)—Classical holder for the Steinman pin. This type is made of an aluminum alloy which is much lighter than steel and does not require replating. (b)—Type of ice tongs. These are but rarely employed and then only for temporary use. (c)—Hand chuck for inserting the Steinman pin. With this device a pin may easily be inserted through cancellous bone. When it is necessary to thrust it through cortical bone, a breast drill is used. (d)—Steel loops which are attached to Steinman pins. They are made of $5/16$ inch steel. It is desirable to have the pin turn in the holder rather than in the bone; skin infections at the point of puncture are less frequent when the pin is stationary in the bone. (e)—Steel pins used for skeletal traction. The smaller is $3/32$ inch in diameter and 6 inches long. It is used in the olecranon, condyles of the humerus, and in the legs of children. The larger pin is $5/32$ inch in diameter and 9 inches long. These are made of stainless steel and are not tempered hard. The collars are to prevent the pin from slipping off the splint bars and are made of aluminum bar $1/2$ inch in diameter.

fourteen days. We have used the unpadded plaster case and the walking iron as advocated by Böhler.³ In our experience it works when the patient is coöperative and sufficiently ambitious for early restoration to stand some discomfort. We have no special fear of unpadded plaster cases when the plaster bandages are applied smoothly and the part is elevated and watched until a safe period has arrived. A rule to be observed in applying plaster directly to the skin is to place the first layers in a longitudinal direction and

TREATMENT OF FRACTURES

usually as plaster splints. These are then covered with encircling turns. By this method the case can be applied directly to the skin with little danger of the formation of constricting ridges.

Fractures of the tibia and fibula which by reason of comminution or obliquity of the fragments cannot be reduced are placed in traction by means of a pin through the os calcis. The leg is held in a splint which we have devised, with the knee in a slightly flexed position. This splint answers the same purpose as the Braun frame advocated by Böhler,³ but is much less expensive and does not interfere with the nursing care of the patient to the same extent as does this frame. (Fig. 4.) The Thomas splint was formerly used in the same manner, but this does not permit the flexion of the knee, and the perineal counter-pressure is highly objectionable when continued for considerable time, particularly in women.

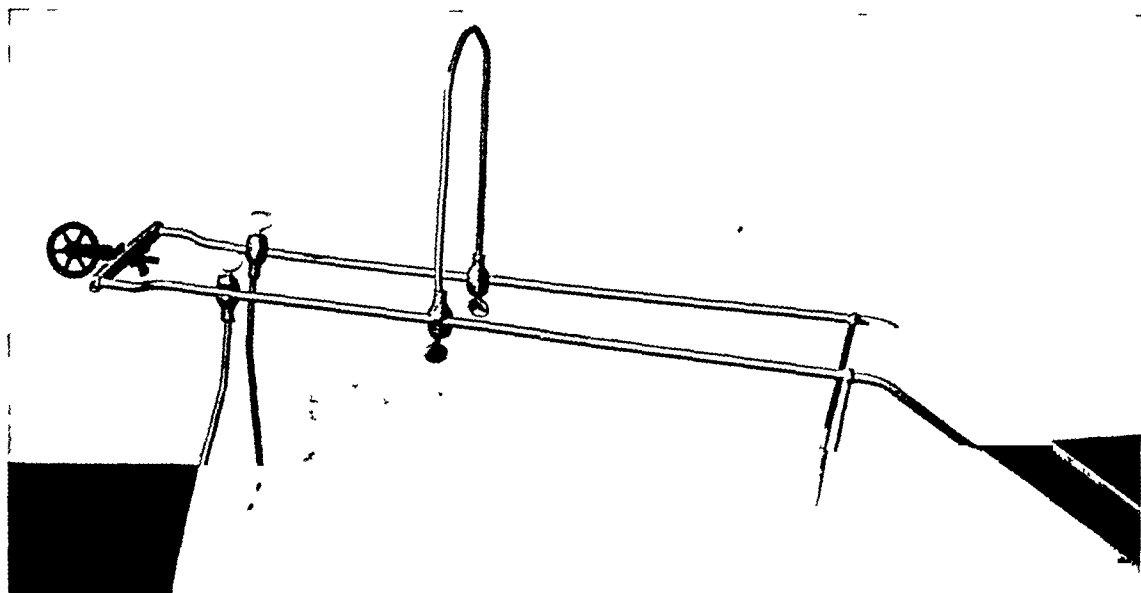


FIG. 10.—A splint used in fractures of the tibia and fibula when traction and elevation are desirable. Another "croquet wicket" may be attached and the entire apparatus may be suspended under a Balkan frame.

Fractures of the Os Calcis.—The plan described by Böhler³ is used. Instead of the frame described by him we have used one which has been attached to the fluoroscopical table and which is ordinarily used for making traction on the forearm. (Fig. 6.) The steps are as follows: Spinal or general anæsthesia is administered. A pin is inserted through the tibia a hand's breadth above the ankle-joint, and another is passed through the os calcis. The leg is suspended by the pin through the tibia with the knee flexed to an angle of 120° . Traction is made downward and in the long axis of the leg by the pin through the os calcis and counter traction is made by a sling about the lower end of the thigh. The spread fragments of the os calcis are then squeezed back to the thickness of the other os calcis by means of the Böhler redresseur clamp. After this a case of plaster applied direct to the skin covers the leg to the knee. The pins are removed as soon as the plaster has hardened completely.

Head Injuries.—Scalp wounds are immediately débrided and explored. Stereoscopical X-ray films are taken with the injured side down, as soon as the patient's condition permits. If the patient is in shock, the examination is limited to that which can be made with a minimum exposure of the patient. If the patient is not in shock a complete neurological examination is made and the findings recorded. If the pulse is slow, consciousness blunted, or focal symptoms are present, a spinal puncture under local anæsthesia is made, always measuring the pressure of the cerebrospinal fluid and noting the



FIG. 11.—A method of treating some fractures of the humerus. The weight of the plaster case makes traction on the lower fragment and to some extent stabilizes the arm. The sling is passed through the wire ring instead of around the forearm where it readily slips.

degree of intracranial bleeding. This pressure is measured by a simple type of manometer which registers the rise of the spinal fluid in a glass tube. The routine nursing observation includes half-hourly records of the pulse and respiration, and notification of the physician if the pulse rises above 100 or falls below 60 and if the respirations become unusual. Blood-pressure readings are made frequently. If the spinal-fluid pressure is above twenty centimetres fluid is withdrawn till it is fifteen centimetres or lower. If the pressure is extremely high—thirty-five centimetres or more—withdrawal is made cautiously and slowly and the pressure is not reduced below twenty centimetres. A spinal puncture is repeated as often as three times a day

when a high pressure is sustained. The head of the bed is elevated, and fifty cubic centimetres of 40 per cent. glucose are given intravenously every eight hours while the pressure remains high. The total intake of fluids is restricted to 2,000 cubic centimetres during twenty-four hours.

More than 4,000 spinal punctures have been made and there has not occurred a sudden death due to herniation of the medulla through the foramen magnum. In the past two years fewer decompressions have been made for sustained high intracranial pressure. We have depended almost entirely on chemical shrinkage of the brain or repeated spinal punctures for reduction of the pressure.

Our treatment corresponds closely to that described by Temple Fay,⁴ Dowman,⁵ and Kennedy and Wortis,⁶ in recent reports. The following types are operated upon: (1) Extradural hæmorrhage; (2) depressed fractures; (3) fractures associated with focal symptoms indicating lacerations of the cortex, localized intradural bleeding, or intradural accumulations of cerebrospinal fluid due to the fluid escaping through rents in the arachnoid.

Fractures of the Pelvis.—When accompanied by laceration of the bladder or urethra, the visceral complication is given attention by the members of the urological service. When there is no visceral complication and the fracture is not grossly displaced, the treatment is rest in bed on a springless mattress for six to eight weeks. This treatment is employed when the patient can lie comfortably and not have pain during the shifting occasioned by ordinary nursing care. When slight movement causes pain a body plaster case is applied from axilla to knees. The legs are slightly abducted and the thighs are flexed to about ten degrees. In two instances separation of the pubis has been restored to a suitable degree by a tight swathe. In two other cases the patient has been suspended by a swathe about the pelvis. The suspending straps are crossed above the patient's body so that the lateral compressing force of the swathe is increased. Three cases have required open operation and fixation. The result has been great improvement of position, but no perfect restoration.

Central Dislocations of the Femur.—In the past year there have been two complete central dislocations of the head of the femur, which have been replaced by manipulation. In each case the manœuvre was as follows: The patient was fixed in bed by a swathe about the body, fastened to the bed rail on the side of the body opposite the injury. One assistant made lateral traction by a band about the upper thigh; a second assistant pulled in the long axis of the leg, while a third person attempted to aid by pressure on the head of the femur with a finger in the rectum. In both cases the finger in the rectum could feel the head slip out when the pull was exerted. The replacement did not require the exercise of great force. In one case the position was maintained by a spica plaster case and in the other a large screw eye was screwed into the trochanter and lateral traction was made. This patient had had a guillotine amputation below the knee which required dressing which made a plaster case not feasible.

Fractures of the Spine.—When the condition of the patient permits, fractures in the cervical region are manipulated under anæsthesia. The manœuvres of Walton⁷ and Langworthy⁸ have been used. After this manipulation, traction on the head is maintained for six weeks. This is followed by fixation of the neck for three months by a helmet and body plaster case, or the Thomas collar. In some cases success in effecting a complete replacement has been obtained. In others the position was only moderately improved. In no case has the manipulation been followed by cord or root symptoms.

Crushed fractures of the bodies of the thoracic and lumbar vertebræ are treated by the procedure of Davis,⁹ and a plaster case is supplied with the body hyper-extended. The case is worn for eight to twelve weeks. After removal of the case a Taylor brace is fitted and is worn until the patient has no discomfort. In several cases the spine has been fused by an Albee bone graft. This was done when fixation of the vertebræ was inevitably necessary and when prolonged use of a brace was not compatible with the patient's following his occupation. We have not had enough experience with this operative procedure to enable us to give any definite judgment as to its merit. Two patients are definitely unimproved, and have been unable to resume work after two years. Several others have resumed work of lesser stress. As with many other injuries entailing possible prolonged discomfort, the question of compensation introduces a variable which makes for considerable uncertainty of prognosis.

Fractures of the Humerus.—In the case of fractures of the neck and epiphyseal separation, with impaction and good position, our uniform plan is to immobilize the arm by a swathe about the body and to hang the forearm by the wrist in a sling. Motion of the forearm is begun early—gentle swinging at first, gradually increasing to full motion. Our plan follows closely that described by Roberts.¹⁰ When the position is not satisfactory treatment has been by traction at a right angle with the forearm flexed. (Fig. 7.) Manipulation has usually been unsuccessful, because the head cannot be sufficiently fixed by grasping through the deltoid mass while the long distal fragment is manipulated. In our experience the cumbersome plaster bandaging holding the arm abducted or the aeroplane splints are quite unnecessary in the ordinary case.

Fractures of the shaft of the humerus are treated by reduction and application of a plaster bandage from wrist to axilla with the forearm flexed to a right angle. (Fig. 11.) A ring of wire is incorporated in the upper side of the cast at the wrist and through this the suspending sling is threaded. This treatment does not furnish immobilization, but it does restrict motion. The weight of the cast applies traction while the patient is standing or sitting. The sling is passed through the ring rather than about the forearm because, when in the former place, the sling cannot slide up toward the elbow and vary the traction. When a fracture is transverse and can be reduced it is usually fixed firmly to a triangle interposed between the arm and body; the arm and forearm are immobilized with plaster. This method of fixation is changed to

the less cumbersome method described above as soon as provisional callus has fixed the fragments so that they will not be displaced by slight motion.

Fractures of the humerus about the elbow-joint are treated by reduction and fixation in acute flexion which is maintained by the gage halter of Hugh Owen Thomas or an Ashhurst dressing.* If swelling of the arm prevents this the arm is sharply elevated by an inclined plane or suspension, and later reduced and fixed, as described, when the swelling permits. In our own cases there have been no instances of Volkmann's contracture. This position of acute flexion is maintained for four weeks; then the forearm is placed in a sling at a right angle for two weeks. Early passive motion is not used. No case has failed to recover complete flexion, though several cases have recovered extension to only 135° at the last observations. However, these were cases in which accurate reduction was not obtained.

Fractures of the Ulna and Radius.—Colles' fractures and fractures of the radius and ulna are reduced under the fluoroscope after "finger traps," with interposed spring balances, have been applied to the fingers and thumb.¹¹ (Fig. 8.) Counter-traction is made with a sling about the arm just above the elbow, and the traction straps are tightened until the spring balances register fifteen to twenty pounds. The anæsthesia is usually novocaine. After a few minutes' traction the fragments are reduced by manipulation. In Colles' fractures a plaster case is applied directly to the skin from the elbow to the fingers. This case is worn for four weeks during which period active use of the fingers is encouraged. When the fracture is higher in the forearm, or involves both bones, one-half-inch dowel sticks are pressed into the plaster splints opposite the interosseous space and are held in place by encircling turns of plaster. This bandage remains in place for six weeks.

Fractures of the olecranon, with separation of fragments and impaired power of extension, are considered frank cases for an open emergency operation. The fragments are usually fixed with wire which passes through the shaft of the ulna and through the triceps tendon just above the upper fragment. After this operation no fixation is applied to the elbow, the arm is simply hung in a sling at a right angle. In fractures of the olecranon without separation of fragments and no impairment of extension no dressing except a sling is employed. Fractures of the olecranon are never fixed in extension. No cases of infection have followed immediate open operations on fractures of the olecranon when the fracture was not compound. There was one infection in a compound fracture.

In cases of fractures of the head and neck of the radius, with much displacement of the fragment, immediate removal of the head seems to be the

* *Ashhurst Dressing.*—This is a position of hyperflexion with the hand as near the shoulder as it can be brought and not across the chest. The fixation is obtained by means of a bandage which commences at the wrist, the end being left long. It then is wound around the upper arm and the elbow with circular turns, the latter being fixed with vertical turns. The dressing is completed by tying the ends of the bandage at the wrist, then knotting them around the neck.

procedure of choice. Non-operative measures, in a few cases where the head was split and the fragments slightly displaced, were frequently followed by abolition of the power of pronation and supination.

Fractures of the Ribs.—In crushed fractures of the chest with multiple fractures of the ribs our procedure is as follows: (1) The patient is propped up in bed in the position in which he breathes most comfortably; (2) the chest is strapped; (3) the patient is put under an oxygen tent at once. The early and prolonged use of oxygen seems to be of paramount importance; (4) morphine is given liberally; (5) air or blood in the chest is aspirated as indicated. If possible, this is not done until after three or four days, in order to allow the points of escape of blood and air to become closed.

SUMMARY

(1) The organization and the procedures for the treatment of fractures in the Cincinnati General Hospital are described.

(2) A large variety of fractures are admitted to the hospital each year. A summary of the different types admitted in one year is given.

(3) There is a brief consideration, with illustrations, of our present methods of treating these various types of fractures.

(4) Practically all of the illustrations are modifications of classical apparatus which have been changed in form, but not in principle, to meet our requirements of economy and a more or less standardized method of handling large numbers of fractures. Almost no commercial splints are used because the quantity and variety necessary could not be afforded, and, also, because it is desirable that the numbers of the house staff shall come to depend on their own resources. Most of the apparatus is made in the mechanical shops of the hospital.

BIBLIOGRAPHY

- ¹ Wilkie, D. P. D.: *Surg., Gynec., and Obst.*, vol. xlv, p. 529.
- ² Bryant, Thomas: *Practice of Surg.*, vol. ii, p. 405, London, 1876.
- ³ Böhler, Lorenz: *Treatment of Fractures*, Vienna, 1929.
- ⁴ Fay, Temple: *Jour. Iowa Med. Assn.*, vol. xx, pp. 447-466, October, 1930.
- ⁵ Dowman, C. E.: *Southern Med. Jour.*, vol. xx, pp. 448-452, May, 1927.
- ⁶ Kennedy, Foster, and Wortis, S. Bernard: *Jour. Amer. Med. Assn.*, vol. xcvi, No. 16, pp. 1352-1353, April 16, 1932.
- ⁷ Walton: *ANNALS OF SURGERY*, vol. xl, p. 645, 1904.
- ⁸ Langworthy, M.: *Jour. Amer. Med. Assn.*, vol. xciv, pp. 86-89, January 11, 1930.
- ⁹ Davis, Arthur G.: *Jour. Bone and Joint Surg.*, vol. xi, pp. 133-156, January, 1929.
- ¹⁰ Roberts, S. M.: *Jour. Amer. Med. Assn.*, vol. xcvi, pp. 367-373, January 30, 1932.
- ¹¹ Caldwell, J. A.: *Jour. Amer. Med. Assn.*, vol. xcvi, p. 1226, 1931.

COLP AND MAGE

was 2,250. Joints adequately protected by large muscles such as the hip and shoulder are not as liable to injury as those guarded mainly by tendinous structures such as the wrist and ankle. (Table II.) Joints of the lower extremity, hampered by weight-bearing, are more prone to injury than those of the upper, in which the conditioned reflexes are quicker and more adept in protective movements. Moreover, the range of evasive motion of the entire upper extremity is enhanced by the great mobility of the shoulder-joint.

This group of fractures rarely shows much displacement, and the alignment of the bone fragment is usually good. Localized direct violence, which plays the foremost rôle in the mechanism of these injuries, should tend to produce comminution with separation of bone fragments. Great displacement, however, is prevented by a dense fibrous joint capsule reinforced by surrounding ligaments. In such joints as the hip and knee, the intra-articular ligaments have an additional stabilizing and immobilizing influence.

TABLE III
Association of Other Fractures with Fractures into Joints

| Upper Extremity—31% | Cases |
|---|-------|
| Fractures into glenoid of scapula associated with other fractures | 3 |
| Fractures of the humerus—upper end | 1 |
| Fractures of the humerus—lower end | 0 |
| Fractures of the ulna—upper end | 1 |
| Fractures of the radius—upper end | 2 |
| Fractures of the radius—lower end | 4 |
| Fractures of the carpus | 5 |
| | |
| Lower Extremity—25% | Cases |
| Fractures into acetabular cavity associated with other fractures | 2 |
| Fractures of the neck of the femur | 0 |
| Fractures of the lower extremity of the femur | 0 |
| Fractures of the patella | 4 |
| Fractures of the tibia—upper end | 3 |
| Fractures of the tibia and fibula—lower end | 8 |
| Fractures of the tarsus | 8 |

While a study of Table III indicated that 26.5 per cent. of joint fractures are associated with fractures of other bones, a glance at Table IV shows that less than 1 per cent. present evidences of compounding. This low incidence of soft part injury may be due to the protective influence of the overlying clothing and the small displacement of fragments which makes the projecting bone improbable.

TABLE IV
Presence of Compounding in Fractures into Joints

| | | |
|--------------------------------------|---|---------|
| Patella fractures | 2 | } 0.65% |
| Tibia and fibula—lower end | 3 | |
| Tarsus | 1 | |
| Humerus—lower end | 1 | |
| Radius—lower end | 1 | |

TREATMENT OF JOINT FRACTURES

The treatment of the associated compounding is similar to that usually employed in any contaminated accidental wound. Tetanus antitoxin is given routinely, and if a gas-bacillus infection is a possibility, a prophylactic dose of the immunizing serum is injected. The wounds are thoroughly irrigated and carefully débrided. Wounds of the upper extremity are then sutured in layers without drainage. Wounds of the lower extremity, however, are left open and packed with gauze, only the underlying joint capsule being closed. This latter precaution has been found necessary because of the greater incidence of anaërobic infections encountered in the lower limb injuries. If infection should intervene in any sutured wound, it is immediately opened, and if a suppurative arthritis is present, the joint is properly and adequately drained and the Willem's treatment instituted if feasible.

The physical signs of joint fractures and the importance of röntgenological studies have already been fully emphasized by others, but the therapy of these cases requires a more careful study. There are several basic principles of treatment which must aim to combat the factors making for a poor result. Actual intrinsic joint injury resulting in a definite irregularity of the joint surface interferes with function. Every attempt, therefore, should be made to establish normal alignment of the joint surface if the displacement warrants. Reduction may be accomplished by manual manipulation under anæsthesia, by the slower process of traction, or by open operation. Fortunately, the displacement of fragments in most joint fractures is not marked. The possibility of exuberant callus protruding into a joint cavity, while it is a conceivable complication, has never been noticed in this series, and it is slight, for it has been definitely shown that synovial fluid acts as a deterrent to callus formation. The compromise of extra-articular and peri-articular tissues, which may result in fibrous connective-tissue adhesions and contractures restricting the range of joint motion, is a serious complication which may be prevented by effective treatment. This may be partially accomplished by the immediate application of radiant heat and gentle massage whenever feasible, aided as soon as possible by early active motion within normal limits. These measures effectively prevent the organization of intra-articular blood and extra-articular exudates, maintain muscle tone, and thus reduce the possibility of adhesions within and contractures about the fractured joint. Physiotherapy, to be effective, must be employed early, not late in a vain endeavor to undo the results of poor surgical treatment. It should always be given by a competent physiotherapist under direct surgical supervision.

As a rule, active motion need not be delayed because of the fear of increasing deformity, for the original displacement of fragments is usually small and is rarely made worse by manipulation. It is only the exceptional case complicated by unusual comminution and marked separation of the fragments which is aggravated by early motion. The production of an arthritis through early motion is more likely to be theoretical than real unless there is an underlying arthritic tendency. While early motion is emphasized in obtaining a good functional result, weight-bearing should be deferred until union is

firm, for the direct pressure may cause a splaying of the bones comprised in the injured joint.

However, there are types of joint fractures in which immobilization is to be preferred to early motion. Fractures complicated by a severe compromise of ligamentous and capsular attachments resulting in dislocations do better if motion is delayed until the ligamentous injuries have been firmly healed. In these instances the application of traction to maintain reduction may permit the institution of motion at an earlier period without the disturbance of fragments. Immobilization is also preferable to active motion in arthrodial joints, for the constant slight play of the fragments in a relatively staple joint tends toward non-union, arthritis and persistent pain. But none of these measures precludes the use of immediate heat and gentle massage.

Then there are the unusual joint fractures in which the fragments become so displaced that function is interfered with by malunion, by non-union, or by small fragments lying free in the joint. These are usually best treated by operative measures. These displaced fragments may be replaced and held by suture or metal appliances. If the fragments are small they may be removed, unless this would interfere with joint function or bony growth. Severe ligamentous damage resulting in a wide separation of bone fragments or a marked subluxation of the joint may require immediate repair. The same basic principles of treatment in joint fractures already outlined should follow all operative procedures.

While these general principles form a basis for the treatment, they cannot be used routinely. Each case must be judged on the individual physical findings. In order to clarify certain special features, each group of joint fractures will be considered in detail.

Fractures of the Scapula.—The majority of fractures involving the joints of the upper extremity are of an ambulatory nature, and as a rule are treated in the out-patient department. This may account for the relatively small series of certain groups of fractures treated in the wards.

There were five fractures of the scapula involving the glenoid fossa. Two of these were associated with fractures of the clavicle and were, therefore, treated by immobilization with a Sayre dressing. The others were treated by heat and massage and active motion as soon as the condition of the patient warranted. Two cases were seen subsequently, one at the end of six weeks, and the other at the end of four months, both having satisfactory results.

Fractures of the Upper Extremity of the Humerus.—Fractures of the humerus entering the shoulder-joint are exceedingly rare because of the peculiar anatomical formation of the head and its relationship to the capsular ligament. There were two cases of this type, one complicated by an impacted fracture of the surgical neck, and the other by a readily reducible subcoracoid dislocation. Both were treated by immediate active and passive motion, heat and massage. The patients, when examined a year later, had perfect end-results, one returning to work ten weeks after injury.

Fractures of the Lower End of the Humerus.—These injuries, which

occur most frequently in children and adolescents, are more often seen in institutions serving residential areas. They were comparatively rare in this clinic. The treatment of simple fractures, without displacement extending into the joint through one or the other condyle, consists of an adhesive or bandage dressing immobilizing the elbow in acute flexion. Active and passive motion under the direct supervision of the attending surgeon is started within a week and is continued daily. The retentive dressing in these simple cases is discarded in fourteen to seventeen days. T-shaped intercondylar fractures with separation of the fragments may necessitate open operation with fixation of the fragments, and displaced or rotated condyles should be replaced. If chip fractures are present and lie free in the joint, removal of the foreign body is indicated. If closed reduction, however, is satisfactory, motion at the elbow should be delayed until sufficient union of the fragments has taken place to prevent displacement. The retentive dressing is routinely discarded by the seventeenth to the twenty-first day. The responsibility of the after-care must be taken personally by the surgeon and should not be intrusted to the physiotherapist until the danger of displacement of fragments has passed.

Six cases constitute this group, one of the external condyle, three of the internal condyle, one of the trochlea, and one of the capitellum. Reduction under anæsthesia was necessary in one case, and all were treated by acute flexion at the elbow-joint. Radiant heat, massage, and active motion were started at the end of one week. One child was operated on seven weeks after injury because of marked limitation of flexion and extension due to an external condyle which was rotated and displaced. This deformity was corrected and the condyle sutured to the humerus. The subsequent result was good.

Fractures of the Upper End of the Ulna.—The principles of treatment are quite similar to patella fractures. If the separation of the olecranon fragments is small, the treatment is conservative; if large, open operation is indicated, with active motion at the end of a week. The olecranon itself should be sutured, for the suture of the triceps tendon alone is usually inadequate to maintain the fragments in apposition. The elbow is partially immobilized at a right angle by means of a posterior molded splint, and active motion is delayed until the twelfth day.

There were six cases of this variety, three being treated conservatively and three by operation. In the former group, the elbow was supported in a sling, and physiotherapy was started within three days after injury. In the operative group, the results were satisfactory, except in one case which was complicated by a compound dislocation of the ulna and a fracture of the head of the radius. The dislocated ulna was reduced immediately, and eleven days later the head of the radius was removed and the olecranon was sutured with chromicgut. Motion was started on the third day after operation, with an unfortunate rupture of the chromic sutures. This was further complicated by an infection which eventually resulted in an ankylosis of the elbow. In the future, it might be advisable in cases of this nature to employ fascial sutures to withstand the tension of early motion.

Fractures Involving the Upper End of the Radius.—There were eight cases of this nature. The treatment depends upon the type of fracture, the location and the degree of separation of the fragments. It is felt that the only cases which should be treated conservatively are those in which the fracture is incomplete. Cases in which there is displacement respond better to open operation. Some feel that removal of the displaced fragment is all that is necessary. If, however, on pronation, the fractured portion of the radial head comes into direct contact with the lesser sigmoid notch of the ulna, only further trouble can be anticipated from this procedure. The operation of choice is the complete removal of the radial head, which is a simple procedure. This is followed by active motion within twenty-four hours. The results obtained have been excellent. One case was treated conservatively, seven were operated, the head being removed in six and the fragment in one. Six were followed, and all had good results.

Fractures of the Lower End of the Radius.—The fundamental principle of early motion applies most strongly in fractures of the lower end of the radius extending into the wrist-joint. The potential impairment of function resulting from these injuries may compromise the skilled function of the hand and the muscular power of the entire extremity. The actual management of these fractures is dependent on the specific pathology encountered. Simple fractures extending through the articular surface without impaction and displacement of the fragments are started immediately on motion, heat and massage. A volar splint of plaster may be used for a few days merely for reasons of comfort.

Those fractures with displacement, impaction, or comminution should be reduced as early as possible, striving for the best anatomical restoration, especially of the inferior radio-ulnar articulation. A volar molded plaster splint extending from the elbow to the metacarpal phalangeal joint is applied with the wrist in moderate flexion and ulnar deviation. Heat and massage are started within twenty-four hours, and active motion of the fingers and wrists in two to three days.

If the comminution has been severe and the danger of displacement is imminent, motion is delayed until some adhesion of the fragments has resulted, this may take from five to seven days. While heat and massage are given daily, the splint is not removed until the fifth day, when passive motion of the fingers and forearm is added. By the seventh day the splint is bandaged only as far as the wrist, so that free flexion and extension of the wrist and fingers are possible. The patients are urged to exercise the fingers and wrist regularly throughout the day so that relatively constant motion is obtained in addition to the periodic physiotherapeutic treatments. The splint is abandoned in the more complicated fractures between the tenth and seventeenth days. The objective is a complete return of function by the end of the third week. If closed reduction is unsatisfactory, open operation is indicated. These cases are comparatively rare, but in two in which displaced and rotated

TREATMENT OF JOINT FRACTURES

comminuted fragments prevented reduction, operation was successful in effecting a good anatomical restoration.

Fractures of the Carpus.—The distribution of carpal fractures is noted in Table V.

TABLE V

| | | | |
|---------------------------------|----|---------------------------------|---|
| Fractures of the scaphoid..... | 10 | Fractures of the semilunar..... | 1 |
| Fractures of the os magnum..... | 1 | Fractures of the navicular..... | 1 |

There seems to be no standardized satisfactory method of treatment. The three fractures of the cuneiform, semilunar, and os magnum respectively, were partially immobilized in volar molded splints for three weeks, radiant heat and massage being started after the third day. The results in two instances were satisfactory, in the other, unknown.

Three of the scaphoid fractures were treated by rest in a simple volar molded splint with the wrist in extension for three to four weeks and by the application of physical therapy. The result was satisfactory in only one case. Four cases were operated on, the entire scaphoid being removed. Two were operated on immediately because of an associated semilunar dislocation, and the follow-up result in one was poor. Two cases were operated on because of persistent discomfort following conservative treatment, and while the patients were improved, they still complained of a weakened wrist. It would seem advisable at present to postpone operation until conservative measures of absolute immobilization have been tried. The carpus has been completely immobilized with the thumb in extension and abduction in three recent cases, the plaster extending from the elbow to the metacarpophalangeal articulation. After ten weeks, physiotherapy was instituted. Repeated X-ray examinations were made for evidence of bone healing. If discomfort should persist and non-union result, scaphoidectomy is indicated. In two cases followed, the result of this conservative treatment was excellent.

Fractures into the Phalangeal Joints.—Simple fractures of the phalanges involving joints were seen very rarely on the ward service. The treatment of these cases is immediate active and passive motion. Cases with marked displacement usually are associated with soft part injury and are frequently caused by crushing violence. The compromise of the highly specialized tendinous structures of the fingers may seriously impair function, and the results at best are not too promising. These cases are treated by traction obtained through needles passed through the terminal phalanges and attached to a banjo splint. Heat and massage are started immediately, and motion is encouraged as soon as feasible.

Fractures of the Os Innomiatum.—The treatment of fractures into the acetabulum is similar to that of the average fracture of the pelvis. These cases, of which there were four, were given rest in a bed reinforced with a fracture board to insure greater immobilization. Active motion was permitted as soon as the patient could move without pain. At the end of six to eight weeks, the patient was allowed up with crutches, and these were discarded as

soon as possible. In two cases in which the acetabular cavity was actually driven inward by the head of the femur, no ill results were seen following this type of treatment. In fact, one patient was walking about with a normal gait and without complaint four months after discharge.

Traction and abduction in those cases in which the femoral head has been driven into the acetabular cavity were discontinued because they were found to be ineffective.

Fractures of the Upper Extremity of the Femur.—While an intracapsular fracture of the neck of the femur is a fracture into the joint cavity, it is really an extra-articular fracture with no actual compromise of the joint anatomy. The basic principles of the treatment of joint fractures, therefore, do not obtain. No differentiation was made between intra- and extra-capsular fractures. There were six cases in this group, one being treated by traction and the remainder in plaster spicas by the Whitman abduction method. The plaster cases were removed after three months; at this time the patients were fitted with walking Thomas caliper splints. These were worn until one year after the injury. The results were good in this small series.

Fractures of the Lower Extremity of the Femur.—Linear fractures of the femur entering the knee-joint either through the condyle or through the intercondylar notch without separation of the fragments can be safely started on immediate active motion. If joint effusions complicate these injuries, repeated aspirations may often be necessary. In cases in which the comminution and wide separation of fragments necessitate reduction, active motion is delayed until some healing of the fragments has taken place.

There were four cases in this series. Each of them will be briefly discussed as representative of a group problem.

One case, a joint fracture complicated by displacement of the lower end of the femur, was treated by a skeletal traction. Ice tongs were inserted into the lower end of the femur, and immediate active knee motion was instituted. Union was obtained in seventy-two days; at that time the tongs were removed. The patient was discharged with an excellent result.

The second case, one with a longitudinal fracture through the medial femoral condyle, was complicated by an enormous bloody effusion into the knee-joint. This was treated by repeated aspiration followed by active motion. The patient was discharged at the end of three weeks with crutches, and these were discarded at the end of two months. The final result was perfect in all ways. The third patient, one with a longitudinal fracture through the medial condyle into the joint, was treated immediately by active motion. The patient was walking about with crutches, bearing weight, at the end of seven weeks, and when seen four months later, had a perfect result. The fourth case, an oblique fracture through the lower third of the femur extending into the knee-joint with marked overriding, exemplifies a type of case in which it is advisable to delay motion. Traction with a Steinman pin through the head of the tibia was instituted, with a satisfactory anatomical reduction. Heat and massage were started within a week, but motion was delayed twenty-one days to allow some healing of the fragments to diminish the danger of displacement. This patient developed a mental condition necessitating transfer to another institution, but at the end of ten weeks had a satisfactory functional and anatomical result.

TREATMENT OF JOINT FRACTURES

Fractures of the Patella.—There were twenty-nine in this series. The treatment is fairly well standardized and is dependent upon the degree of separation of the patella fragments. The treatment is conservative if the separation is negligible. There were nine cases of this type. The extremity was put at complete rest with a posterior splint to assure absolute immobility. In three cases in which effusion into the knee-joint was marked, aspiration was followed by the immediate application of a pressure bandage. In cases of marked soft part contusion, an ice bag was applied to relieve pain and reduce swelling. Active motion was started as soon as the pain had subsided sufficiently. The patients left the hospital after one to two weeks and were instructed to bear weight as soon as they could do so with comfort.

When the separation of the patella fragments is marked, operation is indicated. It should be performed immediately unless the overlying skin is abraded. Effusion into the knee-joint is no contra-indication. Twenty patients in this group were operated on, eleven on admission and nine at varying periods after the injury. The operation consisted of suture of the vasti expansions in sixteen cases, and of additional suture of the patella in four. The latter procedure is really unnecessary if the lateral expansions are properly sutured, although many clinics still practice direct approximation of the patella fragments with chromic gut, silver wire, or fascia. A posterior molded splint was always applied following operation.

If the post-operative course was uneventful, the patella was gently moved on the tenth day, and active motion was encouraged on the sixteenth. The patient was allowed up with crutches about the twenty-first day. The end-results of patella fractures were gratifying, for follow-up examinations usually disclosed a complete restoration of flexion and extension. There were no cases of refracture of the patella in this series.

Fractures of the Upper End of the Tibia.—Fractures of the upper end of the tibia involving the knee-joint were invariably caused by severe direct violence. Comminution, therefore, was the usual finding. The more severe injuries may be complicated by a rupture of the extrinsic or intrinsic ligaments of the knee-joint or by actual dislocation. In these instances the stability of the joint must be reestablished by an adequate repair of the lateral ligaments before motion is instituted.

There were five cases in this series. In two there was fracture of the medial condyle; in two, fracture of the lateral condyle; in one, fracture of both condyles together with the intercondylar notch. Three were associated with fractures of the head of the fibula. For purposes of description these cases will be divided into simple and complicated varieties. In the three simple cases, the treatment consisted of rest in bed, immediate radiant heat, and light massage with motion starting as soon as the patient could bear the pain. Motion was started by the fourth day in four, after a week in one, and not until the thirteenth day in another because of associated injuries. While the knee-joints in these cases showed no marked effusion, they would have been aspirated if necessary, in order to promote a better range of motion.

Patients were allowed up with crutches after about two weeks but were instructed not to bear any weight until ten to twelve weeks had passed, especially if the fractures were comminuted and intercondylar. All these cases were seen in follow-up and presented excellent functional and anatomical results.

There were two cases of the complicated variety in which motion was delayed because of several factors. There was one case of dislocation of the lateral fragment and a slight subluxation of the knee. Motion was begun early but it was found that the subluxation and the separation of the outer fragment seemed to be greater. It was deemed advisable to delay further motion until sufficient union of the fragments had resulted. Although the case was complicated by a persistent phlebitis, which also delayed active motion, there was a reasonably good result.

The second case was an intercondylar fracture and fracture of the tibial spine with a rupture of the medial expansion of the knee-joint and a lateral dislocation. Two attempts at closed reduction were unsuccessful. This patient presented the problem of first repairing the ligamentous injury to assure anatomical restoration of the knee-joint. Naturally, motion must be delayed until sufficient repair has taken place to prevent redislocation. This patient was a chronic alcoholic and developed delirium tremens and bronchopneumonia which resulted in his death four days after admission.

Fractures of the Lower End of the Tibia and Fibula.—Fractures about the lower end of the tibia and fibula, entering the ankle-joint, were seen with almost the same frequency as those involving the knee. The three guiding principles in the treatment of fractures of the lower end of the tibia and fibula are a careful and accurate reduction with the maintenance of the anatomical integrity of the ankle-joint, early motion, and late weight-bearing. Any disturbance in the line of weight-bearing, poor ligamentous healing, or widening of the mortise of the ankle, either singly or collectively, tend to cause poor anatomical, functional and symptomatic results.

Reduction should be performed immediately. Experience has shown that better anatomical reduction can be obtained when anæsthesia is employed. Posterior and lateral molded plaster splints should be used to maintain reduction with the foot at a right angle and in marked inversion. The advantage of this type of splintage lies not only in its obvious safety but in its easy removal for the early application of physiotherapy. There were twenty-four fractures of the lower end of the tibia and fibula, the distribution and treatment of which are tabulated in Table VI.

TABLE VI

| | Total | Reduction under Anæsthesia | Posterior and Lateral Splints |
|---|-------|-------------------------------|----------------------------------|
| Fractures of internal malleolus | 11 | 5 | 8 |
| Fractures of external malleolus | 2 | 0 | 2 |
| Fractures of both malleoli | 11 | 6 | 11 |

In simple fractures through one or both malleoli into the joint without displacement, heat, gentle massage, and active motion of the ankle were given immediately, but weight-bearing was delayed four to six weeks. In cases without severe ligamentous compromise in which anatomical reduction was necessary, massage and motion were usually started about one week after

TREATMENT OF JOINT FRACTURES

injury with temporary removal of only the lateral splints. The posterior splint was usually temporarily removed after three weeks, and both were discarded about one week later. Weight-bearing was permitted after a lapse of six to eight weeks. In those cases in which the ligamentous injury had been severe enough to permit a dislocation of the foot, accurate anatomical reduction was the first requisite. The splints were left undisturbed for three weeks before physiotherapy was started. Weight-bearing in these cases was permitted about the tenth to twelfth week.

Twelve of these cases were seen subsequently, and the majority had good results although many complained of a persistent œdema about the ankle with some impairment of dorsi flexion.

Fractures of the Tarsus.—Fractures of the os calcis were the tarsal fractures most frequently encountered, and because of their importance they will be discussed in greater detail. Isolated fractures of the other tarsal bones are tabulated in Table VII.

TABLE VII

| Fracture | Individual | Associated Fractures |
|------------|------------|---|
| Os calcis | 19 | Scaphoid, 3 Cuboid, 1 |
| Cuboid | 2 | Tibia and fibula, 2 Os calcis, 1 Navicular, 1 |
| Navicular | 2 | Cuboid, 1 Os calcis, 3 Tibia and fibula, 1 |
| Astragalus | 2 | Tibia and fibula, 2 |

The treatment of the isolated fractures of the cuboid and navicular are quite similar. They consist of rest from weight-bearing for four weeks and the immediate institution of heat and massage. These cases were not simple, not comminuted, and the results were satisfactory. There was one case of astragalus fracture which was characterized by marked comminution, dislocation of the fragments, fracture of the malleoli, and rupture of the ligaments of the ankle-joint. It was impossible to replace the displaced fragments by closed manipulation or by traction by means of a pin through the os calcis. Astragalectomy was done with only a fair result.

There is probably no group of fractures which have a poorer functional prognosis than those of the os calcis. Fractures of this bone extending into the associated arthrodial joints are usually associated with a certain degree of comminution and displacement resulting in delayed union, non-union, and arthritis. These factors, as well as the exostosis incident to the splaying of the os calcis, are responsible for the persistent pain and disability on weight-bearing.

It has been very rare to accomplish anatomical restoration by non-operative measures such as molding the os calcis with a mallet, followed by immobilization in plaster. The best results seem to be obtained by a subastragaloid

arthrodesis. This procedure obliterates joint surfaces, practically eliminating the seat of disability.

In this series, there were nineteen cases of fracture of the os calcis involving the surrounding joints. Three of these cases were complicated by other fractures. Eleven of these cases were treated conservatively, operation being suggested to many, but refused. There is no doubt that occasional cases, especially those without comminution and deformity, may do well with rest and the application of a boot, but this is not the general rule. In eight cases a subastragaloid arthrodesis was done. It was customary to wait about three weeks before operation in order to allow the swelling, œdema, and ecchymosis incident to the primary trauma to subside. Following the operation, the foot is held at right angle and encased in a plaster boot for two months. A plate for support of the arch is made then, and the patients are encouraged to walk. The majority of these cases have been seen at the follow-up clinic, and the results have been gratifying not only from the anatomical but from the functional standpoint.

LATE RESULTS OF SEPARATION OF AN EPIPHYSIS

BY JAY IRELAND, M.D.

OF CHICAGO, ILL.

FROM THE CHILDREN'S MEMORIAL HOSPITAL OF CHICAGO, SURGICAL SERVICE OF DR. A. H. MONTGOMERY

IN RECENT years considerable attention has been given to the late results of epiphyseal separation. Many of the articles in the literature comprise brief reports of one to three cases, as those of Meyer,¹ Field,² Sonnenschein,³ and Newell⁴ but with no report months or years after the injury, showing the terminal outcome. As it is rare for any individual to be able to observe the late results of any considerable number of these cases, a review was made of all of the cases with separation of the epiphysis admitted to the Children's Memorial Hospital from the years 1911 to 1931 inclusive. There were twenty-six patients showing this lesion. This analysis is based on the late results in eighteen of these patients, in whom there were nineteen epiphyseal separations. This group of eighteen includes all that could be traced for late examination.

Under the term "epiphyseal separation" various lesions have been described, but in this report only those cases in which the fracture passed through the epiphyseal cartilaginous plate as seen in Röntgenograms are regarded as epiphyseal separations. In addition, in some instances, the fracture extended also proximally or distally from this line. It does not include cases of wandering or slipped epiphyses, as described by Rabb,⁵ Wilson,⁶ and Badgley,⁷ nor osteomyelitic processes, which according to Gold⁸ cause epiphyseal separations in 12 per cent. of cases affected with osteomyelitis of the epiphysis. Also, it does not include those cases described by Werenskiöld⁹ who considers a separation of the epiphysis to be present when there is "a thin lamella detached from the epiphysis at the boundary between the bone and cartilage, and when displacement is not present, this may be the only, but sufficient proof of the existence of an epiphyseal separation." He found this lamella often forms without visibly displaced fragments, and says that this sign is present in 53 per cent. of epiphyseal separations. On this basis he classified 30 per cent. of 209 distal radial lesions as epiphyseal separations. According to him, undisputed epiphyseal separation is quite rare but Gold¹⁰ reported an incidence of 25.9 per cent. of epiphyseal separations of the lower radius in fifty-eight radius fractures. He⁸ also stated that 7.2 per cent. of children's fractures are separations of the epiphyses which is decidedly higher than the percentage at the Children's Memorial Hospital. From the years 1911 to 1931 inclusive, there were 1018 patients with fractures admitted into the hospital of which twenty-two (2.2 per cent.) were separations (four patients were treated in the dispensary and are not included in this calculation). In ninety-six cases of fracture of the upper end of the humerus, Roberts¹¹ reported three as epiphyseal separations. Poland¹² believed that

the epiphysis is often separated without displacement, but only cases showing visible displacement were included in this series.

Table I is a summary of the data obtained from an analysis of the cases in this series.

TABLE I

CASE I.—Female, aged one year. Causative agent.—Scurvy. Bone.—Left lower tibia. Amount of displacement of fragment in centimetres in X-ray before treatment.—.3. Treatment.—Antiscorbutic. Time from injury to final examination.—226 days. External shortening.—.5. Shortening in X-ray.—.6. Epiphyseal line present. Deformity. Functional result.—Normal.

CASE II.—Female, aged one year. Causative agent.—Scurvy. Bone.—Left and right lower femurs. Amount of displacement of fragment in centimetres in X-ray before treatment.—Left, .7; right, .5. Treatment.—Antiscorbutic. Time for injury to final examination.—224 days. Epiphyseal line present. No deformity. Functional result.—Normal.

CASE III.—Female, aged two years. Causative agent.—Fall. Bone.—Right upper femur. Amount of displacement of fragment in centimetres in X-ray before treatment.—1.6. Treatment.—Closed reduction. Time from injury to final examination.—Seven years, 192 days. Epiphyseal line present. No deformity. Functional result.—Pain when jumping.

CASE IV.—Male, aged three years. Causative agent.—Fall. Bone.—Left capitellum humeri. Amount of displacement of fragment in centimetres in X-ray before treatment.—.3. Treatment.—Open operation. Time from injury to final examination.—One year, 144 days. External shortening.—1.3. Shortening in X-ray.—.2. Epiphysis absent. Deformity. Functional result.—Poor.

CASE V.—Female, aged seven years. Causative agent.—Hit by rubber tubing. Bone. Left second metacarpal. Amount of displacement in centimetres in X-ray before treatment.—.3. Treatment.—Open operation. Time from injury to final examination.—Four years, 127 days. External shortening.—.6. Shortening in X-ray.—.6. Epiphyseal line present. No deformity. Functional result.—Normal.

CASE VI.—Male, aged eight years. Causative agent.—Fall. Bone.—Left upper radius at right angle to the shaft. Treatment.—Closed reduction. Time from injury to final examination.—Three years, 198 days. Shortening in X-ray.—.2. No epiphyseal line present. No deformity. Functional result.—Normal.

CASE VII.—Male, aged eight years. Causative agent.—Fall. Bone.—Right upper radius. Amount of displacement of fragment in centimetres in X-ray before treatment.—.5. Treatment.—Closed reduction. Time from injury to final examination.—303 days. Epiphyseal line present. No deformity. Functional result.—Normal.

CASE VIII.—Male, aged nine years. Causative agent.—Fall. Bone.—Right lower radius. Amount of displacement of fragment in centimetres in X-ray before treatment.—.1. Treatment.—Closed reduction. Time from injury to final examination.—Two years, thirty-two days. Epiphyseal line present. No deformity. Functional result.—Normal.

CASE IX.—Male, aged nine years. Causative agent.—Struck finger. Bone.—Right fifth metacarpal. Amount of displacement of fragment in centimetres in X-ray before treatment.—.2. Treatment.—Closed reduction. Time from injury to final examination.—One year, 211 days. Shortening in X-ray.—.3. Epiphyseal line present. No deformity. Functional result.—Normal.

CASE X.—Male, aged nine years. Causative agent.—Fall. Bone.—Right lower radius. Amount of displacement of fragment in centimetres in X-ray before treatment.—.5. Treatment.—Closed reduction. Time from injury to final examination.—230 days. Epiphyseal line present. No deformity. Functional result.—Normal.

CASE XI.—Male, aged ten years. Causative agent.—Fall. Bone.—Left lower radius. Amount of displacement of fragment in centimetres in X-ray before treatment.—.2.2.

RESULTS EPIPHYSEAL SEPARATION

Treatment.—Closed reduction. Time from injury to final examination.—Seventy-four days. Epiphyseal line present. No deformity. Functional result.—Normal.

CASE XII.—Male, aged ten years. Causative agent.—Fall. Bone.—Right lower humerus (medial epicondyle). Amount of displacement of fragment in centimetres in X-ray before treatment.—1.3. Treatment.—Closed reduction. Time from injury to final examination.—187 days. Shortening in X-ray.—.8 longer. Epiphyseal line present. Deformity. Functional result.—Normal.

CASE XIII.—Female, aged eleven years. Causative agent.—Fall. Bone.—Left upper radius at right angle to the shaft. Treatment.—Open operation. Time from injury to final examination.—Three years, thirty-six days. External shortening.—1. Shortening in X-ray.—1. No epiphyseal line present. No deformity. Functional result.—Normal.

CASE XIV.—Male, aged eleven years. Causative agent.—Struck 'box. Bone.—Right fourth finger, third phalanx. Amount of displacement of fragment in centimetres in X-ray before treatment.—.5. Treatment.—Open operation. Time from injury to final examination.—Three years, 211 days. External shortening.—.2. Shortening in X-ray.—.3. Epiphyseal line present. No deformity. Functional result.—Normal.

CASE XV.—Male, aged eleven years. Causative agent.—Fall. Bone.—Left lower radius. Amount of displacement of fragment in centimetres in X-ray before treatment.—1.2. Treatment.—Open operation. Time from injury to final examination.—Eighty-nine days. Epiphyseal line present. No deformity. Functional result.—Normal.

CASE XVI.—Male, aged eleven years. Causative agent.—Fall. Bone.—Right lower radius. Amount of displacement of fragment in centimetres in X-ray before treatment.—.4. Treatment.—Closed reduction. Time from injury to final examination.—Eighty-four days. Epiphyseal line present. No deformity. Functional result.—Normal.

CASE XVII.—Female, aged twelve years. Causative agent.—Hit by falling man. Bone.—Left lower tibia. Amount of displacement of fragment in centimetres in X-ray before treatment.—.5. Treatment.—Closed reduction. Time from injury to final examination.—272 days. External shortening.—1. Shortening in X-ray.—.6. No epiphyseal line present. No deformity. Functional result.—Normal.

CASE XVIII.—Male, aged thirteen years. Causative agent.—Fall. Bone.—Left lower tibia. Amount of displacement of fragment in centimetres in X-ray before treatment.—.3. Treatment.—Closed reduction. Time from injury to final examination.—182 days. Epiphyseal line present. No deformity present. Functional result.—Normal.

In this series there were six girls and twelve boys ranging in age from one to thirteen years, with an average age of eight years and forty days. Except in two cases which were due to scurvy (Figs. 1, 2, and 3), as described by Hess¹³ and many others, all of the separations were caused by injury. None were due to muscle strain (Kahnt¹⁴), birth injury (Harrenstein¹⁵), or syphilis, and none occurred spontaneously.

Separation of the lower radial epiphysis was the most frequent in Gold's¹⁰ cases, as it is in this series, in which it occurred six times (31.6 per cent.) in the nineteen separations. Upper radial epiphyseal separation stands second with three cases; the lower tibia, lower femur, lower humerus, and metacarpus are third with two cases each; and there was one of the upper femur and one of a phalanx of a finger.

The amount of displacement, as measured in röntgenograms, varied from 0.3 centimetre to 3 centimetres with an average displacement of 0.9 centimetre.

Five patients were treated by open operation, eleven were treated by closed reduction, and the two scorbutic patients were given only antiscorbutic medication and diet.

The shortest period of time that elapsed from the time of injury till the final examination was seventy-four days, the longest was seven years and 192 days, and the average was 646 days. Perhaps, if these patients were followed longer, more sequelæ would be found.

The examinations were made especially for late sequelæ including (1) shortening of the bones; (2) premature ossification of the epiphysis to the diaphysis with obliteration of the epiphyseal line; (3) deformity such as cubitus varus in capitellum humeri separation, cubitus valgus following



FIG. 1.—(Case II.) Scurvy. Appearance of the lower femoral epiphyses before treatment. Note the slight increased calcium deposit just above the epiphyseal lines.

epicondylus medialis humeri separation, and coxa vara; (4) arthritic changes; (5) Perthes' disease and cyst formation, and (6) functional disturbances.

(1) *Shortening*.—This lesion of bones has been especially stressed by Harrenstein,¹⁵ Gold,⁸ Linser,¹⁶ McFarland,¹⁷ and Watson.¹⁸ Of the nineteen cases, six (31.6 per cent.) had shortening by external measurements and eight (42.1 per cent.) by röntgenogram measurements, which no doubt are more accurate. In a comparison of the results that others have found, Klinefelter¹⁹ reported twelve cases of epiphyseal separations, three (25 per cent.) of which had arrest of growth. In contrast, Zadek²⁰ reported five cases of separation of the epiphysis of the lower end of the radius, in patients aged

RESULTS EPIPHYSEAL SEPARATION

nine to thirteen years, of which two were operated upon and three were treated by closed reduction, and none of them showed subsequent shortening.

Considering the short period of time in which shortening can occur, McFarland¹⁷ stated that definite shortening may occur within seven months subsequent to the injury. This is quite in agreement with what was found in Case I (scurvy with separation of the lower epiphysis of the tibia), in which a shortening of .6 centimetre was observed in röntgenograms 226 days after the onset. This is the briefest period of time in which a decrease in length was observed.



FIG. 2.—(Case II.) Scurvy. Same patient as in Fig. 1, but after thirty days of treatment. Note both lower femoral epiphyses separated and large, heavy bony deposit extending upward along the shafts.

There is some disagreement in the literature as to whether shortening may be expected. Speed²¹ in 1916 had seen no cases of cessation of growth after a separation of the epiphysis of a long bone but later did see such cases. Patterson²² thinks that the danger of interference with growth has been exaggerated. Indeed, epiphyseolysis of the lower femur has been used as a corrective measure in genu valgum but Jones and Lovett²³ believe that in unskilful hands it is definitely dangerous. However, the above data show that shortening is quite common. Gold,¹⁰ who concurs in this opinion, thinks that separation of the lower epiphysis of the femur is very often followed by premature ossification and cessation of growth. Willis²⁴ stated that a lesion of the upper epiphysis of the femur is always followed by a permanent

fusion of the epiphysis and consequent effect upon growth. This view, however, is not substantiated by Case III of this series which shows no evidence of the old injury in röntgenograms taken seven years and 192 days after the accident and has no shortening.

The causes of the shortening have been attributed to various factors. In the upper extremity, Linser¹⁶ mentions a case of separation of the upper epiphysis of the humerus with 14 centimetres of shortening because apposition was not good. However, poor apposition is not the only factor concerned because in Case XIII (previously reported by Montgomery²⁵) the head of the radius was perfectly replaced at operation. This was confirmed post-operatively by röntgenogram, and yet there was 1 centimetre of shortening at the last examination (three years and thirty-six days after injury). Henderson²⁶ thinks that shortening is due to inactivity of the growing centres. Haas²⁷ is inclined to believe that a vascular disturbance is the cause of growth disturbance. However, the excellent work which he has done on epiphyseal transplantation in dogs does not absolutely prove that vascular disturbance is the only factor involved in shortening, because nerve injury has resulted in epiphyseal arrest of growth, and this factor was not excluded in his work. McFarland¹⁷ thinks that the failure of growth is due to death of cartilage cells either from being crushed or from hæmorrhage into them. He states that a lower radial epiphysis separation is less likely to be followed by shortening than a lower tibial separation. In discussing the lower radial epiphysis he says that only when it is crushed does arrest of growth occur, but does not state how he arrived at this conclusion. He proved, however, that if one-half of the epiphysis of the lower tibia is injured, the injured portion may cease to grow, while the uninjured side continues, thus making a deformity.

In addition to the above etiological factors, Küttner²⁸ found that root and plexus paralysis in childhood caused decrease in the growth of bones. Löhr-Magdeburg²⁹ found shortening due to hæmophilia and ischæmic contractures. Experimentally, he observed that in freezing the epiphyses in rats shortening ensued and that in freezing of the joints and epiphyses, more damage was done to the epiphyses than to the joints.

The patients in this series were examined to determine whether the amount of displacement of the fragments, both before and after reduction, had any influence on shortening. Two patients (Cases VI and XIII), with upper radial epiphyseal separations, had the epiphyseal fragment turned at a right angle to the shaft. Although a perfect reduction was obtained, both had shortening at the last examination with the epiphysis of each showing osseous union to the shaft, but neither had deformity or impaired function. Case XI, who had 2.2 centimetres of displacement of the fragment before reduction, which was the second greatest amount of any in the series, obtained a perfect result in every respect, while Case IX, who had only .2 centimetre of displacement before reduction showed a shortening of .3 centimetre in a röntgeogram one year and 211 days after injury. After reduction, the fracture of Case XI still showed .5 centimetre displacement in röntgeno-

RESULTS EPIPHYSEAL SEPARATION

gram, yet no shortening developed. On the other hand, after reduction, Case XVII still had .5 centimetre displacement, and subsequently had shortening and premature ossification of the epiphysis to the shaft. These observations show that displacement does not necessarily produce shortening and in cases where shortening has occurred, the amount of shortening does not depend upon the amount of displacement. Hence, no conclusion can be drawn as to whether shortening would or would not follow a separation with a stated amount of displacement of the fragments either before or after reduction.

An increase in bone length, such as has been reported in some patients

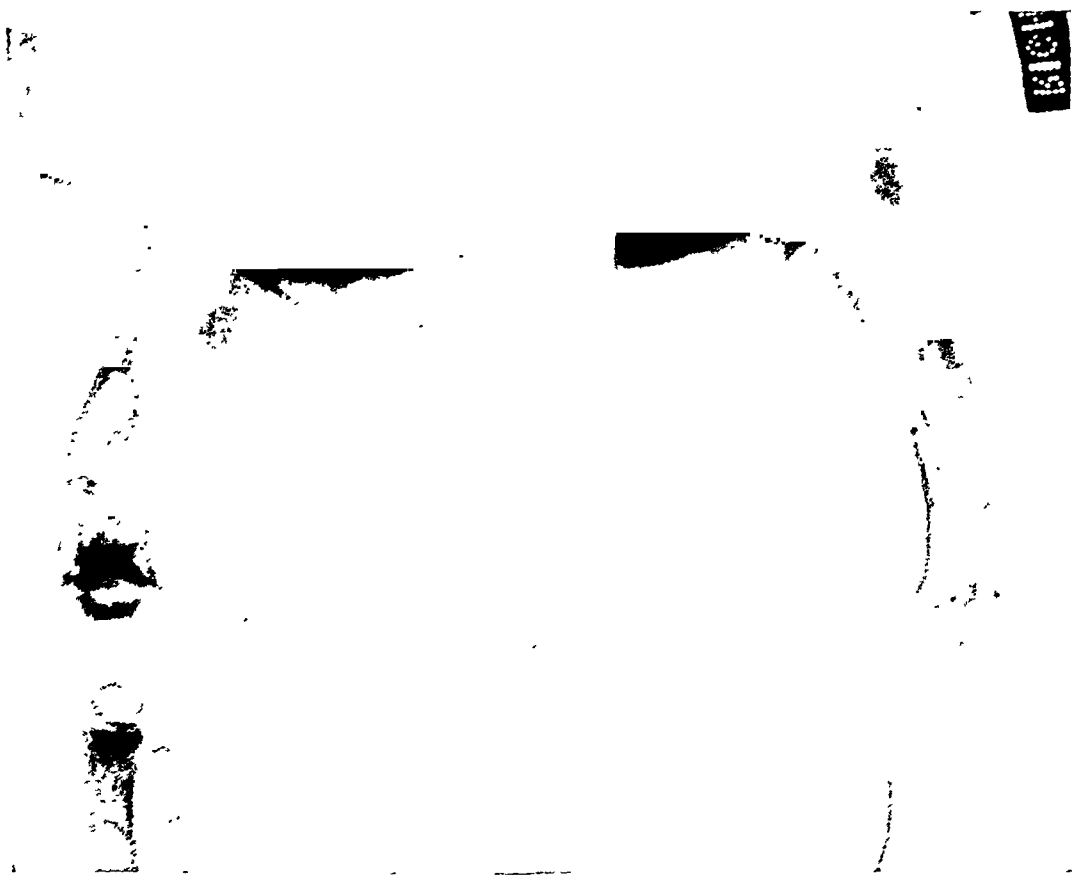


FIG. 3.—(Case II.) Scurvy. Appearance of the lower femoral epiphyses in alignment, one hundred sixty-nine days after beginning treatment. Note disappearance of the large bony deposits.

with osteomyelitis (Speed³⁰) occurred in one patient (Case XII). The cause of this lengthening is not clear. The theory is offered that the injury may have stimulated the growth of epiphyseal cartilage cells to cause the increase in length of the bone.

(2) *Premature ossification of the epiphysis to the diaphysis.*—This abnormal ossification, as described by Löhr-Magdeburg,²⁹ Montgomery,²⁵ Lapidus,³¹ Gold,¹⁰ and Kurlander,³² occurred in three patients (16.7 per cent.) in this series. All of these had shortening, but other than this, none of them had any deformity. However, in four patients (Cases I, V, IX, and XIV) in which there was shortening, the epiphyseal line was still present. It would seem that a certain amount of damage may be done to the epiphyseal cartilage

plate (*i.e.*, enough to cause shortening) and still be insufficient to cause ossification of the epiphysis to the shaft.



FIG. 4.—(Case IV.) Capitellum humeri separation with fragment displaced laterally. Upper end of ulna is also fractured.

Several theories have been offered to explain this premature ossification. Ferguson and Horworth,³³ and Haas²⁷ have suggested that the premature union of the growth centre is evidence of a circulatory disturbance.



FIG. 5.—(Case IV.) Capitellum humeri separation thirty-seven days after injury. Note marked lateral displacement of the capitellum.

Lapidus³¹ stated that the premature disappearance of the epiphyseal cartilage with complete union of the lesser trochanter to the shaft of the femur

RESULTS EPIPHYSEAL SEPARATION

as shown in röntgenograms takes place in about four months. The shortest period of time in which there was a premature disappearance of the epiphyseal cartilage in this group of cases, as seen in röntgenograms, was 154 days. This occurred in Case XVII, with a lower tibial epiphysis separation.

(3) *Deformity*.—Only three patients had deformity other than shortening.

In Case IV the capitellum humeri were separated (Figs. 4 and 5). This patient was treated by a closed reduction followed by a plaster bandage with the elbow in acute flexion. After removal of the bandage, massage and wet soaks were employed. After reduction, the displacement was 2.5 centimetres, but thirty-eight days later it was 3 centimetres, indicating that the fragment had slipped while in the case. As extension and flexion of the elbow were quite limited one year and one hundred and forty-four days after the injury, an open operation was done in an attempt to nail the capitellum in place. However, it was found that when this was accomplished, flexion and extension were not improved, so the capitellum was excised and the ulnar nerve transplanted anteriorly to prevent its being pinched between the olecranon and the inner condyle. The joint is now somewhat flail, cubitus varus is present and when the elbow is flexed at an angle of 90°, pronation of the forearm can be carried out beyond the normal limit. Probably it would have been better to have made further attempts to align the fragments at the onset, perhaps by performing an open operation and suturing the periosteum with catgut. With this patient in mind, all possible means will be utilized in the future to secure proper alignment in capitellum separations. The seriousness of this lesion has been previously emphasized by Gold⁸ who called attention to the incidence of cubitus varus resulting from it.

The second patient (Case I) with deformity, suffered from scurvy and genu recurvatum and genu valgum resulted, as described above. The third patient (Case XII), who had epicondylus medialis humeri separation, had only a slight prominence of this region, which was not considered serious. However, Gold⁸ had called attention to the fact that cubitus valgus may follow this lesion.

Deformity is more prone to follow certain epiphyseal lesions. McFarland¹⁷ stated that progressive deformity is only present in a very small proportion of separations of the lower epiphysis of the radius, but that the reverse is true of the tibia. Harrenstein¹⁵ and Hess¹³ mentioned that coxa vara may follow separation of the upper epiphysis of the femur. Friedrich³⁴ reported a case of coxa vara presumably from an epiphyseal disturbance which occurred fifty years previously, but it is difficult to understand how he arrived at the conclusion that it was an epiphyseal lesion which caused the coxa vara. Recently, Esau³⁵ stated that lower ulnar epiphysis injury may cause a very disabling deformity and suggested that this lesion may be the cause of Madelung's deformity.

Other sequelæ have been reported as following epiphyseal separations. Kurlander³² reported three cases of separation of the lower femoral epiphysis, one of which was followed by gangrene necessitating amputation at the mid-thigh.

Ankylosis was not observed in any case in this series. Cutler³⁶ reported five cases of separation of the lower femoral epiphysis, one of which was followed by a permanently stiff knee and another by external popliteal nerve paralysis. Eikenbary and LeCocq³⁷ reported ten cases of upper femoral

epiphysis separation with the following results: good, four; poor, four, and excellent, two. Two patients were operated on and ankylosis occurred in both.

Following epiphyseal separations, non-union seems to be more rare than after simple fracture of the shaft and no cases of non-union were observed in this series. Watson¹⁸ stated definitely that there have been no cases of non-union following lower radial epiphysis separation. Poland,¹² quoting Hamilton, reported a patient with non-union five months after an injury which produced a separation of the epiphysis of the upper end of the humerus. However, this patient had had no treatment of any kind.

(4) *Arthritis*.—There was only one case (Case IV) with arthritic changes. This occurred in the patient (Figs. 4 and 5) with capitellum separation who was treated by removal of the fragment, as described above. It is questionable whether some of the arthritis in this patient may not be due to operative interference or whether it is all due to absence of the capitellum. Also, this arthritis may become worse later on, as Madlener and Wienert⁸⁸ examined patients for arthritis deformans following olecranon fracture and found that the longer the time since the injury, the more decided were the joint changes.

It is difficult to decide in many cases of arthritis which have been preceded by an epiphyseal separation, just how much the separation contributed to the arthritis. Friedrich³⁴ believes that the greater percentage of arthritis deformans of the hip is the result of early hip disease of some type. However, the case of arthritis of the upper end of the humerus due to an epiphyseal injury in a man seventy-four years old, reported by Nussbaum,³⁹ is open to question, because it would seem difficult to decide what the etiological factor was in a case of so long duration.

(5) *Perthes' disease, cyst formation, etc.*—There were no patients in this series in which Perthes' disease, as described by Driver,⁴⁰ or cyst formation, as described by Muller,⁴¹ occurred. Nussbaum⁴² reported cases of chondroma and osteitis fibrosa probably due to separation of the upper epiphysis of the femur, but Walter⁴³ casts some doubt on this assumption.

(6) *Function*.—Only two patients had poor function. One of these (Case III), with a separation of the upper epiphysis of the femur, had pain on jumping. An examination of this patient showed no apparent cause for the poor function. Röntgenograms taken after reduction showed a perfect apposition of the fragments and röntgenograms taken seven and one-half years later showed nothing abnormal. Apparently, this case does not substantiate the hypothesis of Field,² who, in discussing this particular lesion, stated: "A return to perfect function, one would surmise, would follow a complete and accurate reduction with efficient after-treatment."

The other patient (Case IV), with a capitellum humeri separation, had a flail elbow, as described above. Possibly, the poor result in this patient might have occurred without the removal of the capitellum. However, it is more likely that removal of the capitellum led to the poor result. The operation should not be undertaken in a child before epiphyseal growth has ceased,

RESULTS EPIPHYSEAL SEPARATION

without due consideration of a probable subsequent deformity and loss of function.

In this series one patient showed then slight impaired function from no apparent cause and another showed marked loss of function probably from injudicious treatment. It would seem from this that function is not commonly interfered with, following epiphyseal separation.

Scurvy.—A further word should be added in regard to the treatment of the two patients with scurvy. (Figs. 1, 2, and 3.) Hess¹³ has suggested that splints be applied to patients suffering from scurvy with epiphyseal separations, but no mechanical appliance was used in the treatment of these two patients. During the active stage of the disease, they were kept lying flat in bed, given anti-scorbutic diet, viosterol, sun baths, and cod-liver oil. Fractures in scurvy apparently heal quite readily, since Roegholt⁴⁴ found that in guinea-pigs affected with scorbutus, fractures began to show healing in röntgenograms five days after vitamin C administration.

The result was poor in one patient but excellent in the other. Case I, at the last examination (226 days after the onset), had genu valgum with 6 millimetres of shortening by external measurements and 5 millimetres in the röntgenogram. Better results might have been obtained if a plaster fixation bandage or other appliance had been used. The other patient with scurvy (Case II) also suffered with cretinism. In addition to the above medication she received desiccated thyroid. At the last examination (224 days after the first examination), she had recovered from the scurvy and röntgenograms showed the previously separated epiphyses to be normal.

Factors to be considered in the prognosis.—Different factors must be considered when the various epiphyses are separated. These include the particular epiphysis involved, the age of the patient, and the amount of displacement of the fragments.

The particular epiphysis involved must be considered in the prognosis because separations of some epiphyses seem to be more important than others. Watson¹⁸ and Speed⁴⁵ stated that the epiphysis toward which the nutrient artery points usually unites with the shaft first. One exception to this rule is the fibula, as pointed out by Speed⁴⁵ and Harbin and Zollinger.⁴⁶ Watson¹⁸ stated that the greatest longitudinal growth is produced by the epiphysis which unites last.

One would suspect, other conditions being the same, that the greatest amount of shortening would follow separation of the epiphysis which unites last, but this was not confirmed by an analysis of Table I. Comparisons can be made with only two bones, the femur and radius. There were two patients with lower femoral epiphyseal separations and one with upper, but none of them had shortening. There were five patients with lower radial separations none of whom had shortening as one would expect, but there were three of upper radial separations, two of which had 1 and 2 centimetres of shortening, respectively. It is clearly seen, however, that this number is too small to form any definite conclusions.

Griswold⁴⁷ thought that separation of the lower epiphysis of the femur should be treated by early motion and he treated such a case with complete motion of the femur within seventeen days after reduction and an examination 309 days after the injury showed an excellent result.

The age of the patient is naturally important because the younger the individual, the greater is the risk of shortening and deformity. For instance, one would consider that more shortening would occur in a separation of the lower epiphysis of the tibia which occurred at the age of one and one-half years (one year after the epiphysis forms) than one which occurred at the age of seventeen years (one year before it closes).

The amount of displacement of the fragments, both before and after reduction, according to some authors, must be given due consideration in estimating the prognosis. However, as stated above, no definite conclusions in this respect could be drawn from this series. One is at a loss to say exactly how many millimetres the epiphysis must be displaced as measured in the röntgenograms before operative interference should be undertaken. The question of whether a separation in any individual instance is to be treated by closed reduction or open operation is often difficult to decide. It has been suggested by Linser,¹⁶ Conwell,⁴⁸ and Roberts¹¹ that better results may be expected when apposition is good. This is in agreement with Speed²¹ who stated that a perfect reduction of an epiphyseal separation gives a correspondingly good prognosis, but this is not substantiated by the result in Case XIII, who had perfect alignment, as seen in röntgenograms taken after reduction, and yet had 1 centimetre of shortening. However, this patient was operated upon and the operative trauma may have tended to negative the result.

Judging from the results in this series, open operation is to be avoided if it is possible to obtain a reduction of the fragments otherwise, as none of the five patients operated on had perfect results. Cutler³⁶ and Eikenbary and LeCocq³⁷ had similar experiences. On the other hand, Zadek²⁰ who operated on two patients with separations of the lower epiphyses of the radius had very satisfactory results.

Foreign material placed in the region of the epiphysis should be avoided if possible because of growth interference. If used, it should be of an absorbable nature by preference, or if non-absorbable material is used, it should be removed after the callus becomes hard enough to maintain the position of the fragments. A very good method for holding the fragments in position is to suture them with twenty- or thirty-day No. 3 or 4 catgut, used double if necessary. This is better than kangaroo tendon which is more likely to lead to a suture sinus.

The degree of periosteal separation may be a factor in the prognosis, since Poland¹² stated that the periosteum is the most important element in the production of the callus. If so, the conclusion may be drawn that the more the periosteum is separated, the greater will be the disturbance of the epiphysis. However, it would be difficult to estimate the degree of periosteal separation in any given case. Lapidus³¹ believes that the periosteum is only slightly

RESULTS EPIPHYSEAL SEPARATION

stretched in separation of the epiphysis of the lesser trochanter of the femur and that the repair in these cases is so good that operation is not indicated. The results obtained by Vadsten⁴⁹ with the closed method in separations of the lesser trochanter tend to substantiate this belief.

Summary.—Eighteen patients with nineteen epiphyseal separations were examined from seventy-four days to seven years and 192 days following the epiphysis separation. Sixteen of these separations were due to trauma and three to scurvy. Eleven patients were treated conservatively by closed reduction. Of these, one had shortening and one had lengthening as measured in röntgenogram, two had osseous union of the epiphysis to the shaft, one had deformity and one had poor function, but none had arthritis. Two patients with three epiphyseal separations due to scurvy were treated by simple rest in bed without splints but were given anti-scorbutic food and medication. One had shortening and deformity, but in neither was there osseous union of the epiphysis to the shaft, impaired function, or arthritis. Five patients were treated by open operation. All of these had subsequent shortening as measured in röntgenograms and four showed shortening by external measurements; one had osseous union of the epiphysis to the shaft; and one after removal of the epiphysis had a resulting deformity, poor function, and arthritis.

Open operation is to be avoided if the fragments can be approximated otherwise. Judging from the results obtained in this series, open operation should be done only when absolutely necessary, as it seems to cause a poor result.

The outlook in regard to deformity and function seems to differ in the various epiphyses. The poorest results seem to follow epiphyseal separations of the capitellum humeri, epicondylus medialis humeri, upper and lower femur, lower tibia, upper humerus, lower radius, and lower ulna. There were only three patients with deformity (capitellum, epicondylus medialis humeri, and lower femoral epiphysis separations) and two with poor function (capitellum and upper femoral epiphysis separations). In one patient with a separation of the lower tibial epiphysis deformity will probably occur in a few years, because there is now bony ossification to the shaft at the median aspect and the patient is only twelve years old. This epiphysis normally closes at the age of eighteen years.

All the cosmetic changes were due to shortening and deformity. In only two patients (metacarpal and phalanx of finger separations) was there enough shortening to produce any bad cosmetic effect, and in only three patients (lower femoral, capitellum, and median epicondyle separations) was there a deformity, other than shortening, causing a poor cosmetic result.

Although it might be expected that the greatest amount of shortening would occur in injuries to the epiphysis which unites last in any particular bone, no conclusion could be drawn in regard to this matter from the observations made on this group of patients.

The amount of separation of the fragments as measured in the röntgeno-

gram, either before or after an attempt at alignment, is apparently of no prognostic value as to possible sequelæ. The essential factor is undoubtedly concerned with the integrity of the epiphysis. At the present time there do not seem to be any evident criteria by which this can be determined.

BIBLIOGRAPHY

- ¹ Meyer, A. H.: Epiphyseal Separation Due to Muscular Action. *South. Med. Jour.*, vol. xxiii, p. 587, July, 1930.
- ² Field, G. C.: Traumatic Separation of Epiphyses of Head of Femur. *Brit. Jour. Radiol.*, vol. ii, p. 297, June, 1929.
- ³ Sonnenschein, H. D.: Separation of the Epiphysis of the Internal Epicondyle. *Med. Jour. and Rec.*, vol. cxxvii, p. 298, March 21, 1928.
- ⁴ Newell, E. T.: Fractures, Epiphyseal Separation, and Dislocations. *South. Med. Jour.*, vol. xix, p. 688, September, 1926.
- ⁵ Rabb, J. J.: Slipped Epiphysis of Head of Femur. *Brit. Med. Jour.*, vol. i, p. 643, April 6, 1929.
- ⁶ Wilson, D. P.: Displacement of Upper Epiphysis of Femur Treated by Open Reduction. *Jour. Am. Med. Assn.*, vol. lxxxiii, p. 1749, November 29, 1924.
- ⁷ Badgley, C. E.: Displacement of the Upper Femoral Epiphysis. *Jour. Am. Med. Assn.*, vol. xcii, p. 355, February 2, 1929.
- ⁸ Gold, E.: Über Traumatische Epiphysenlösungen und deren Behandlung. *Arch. f. klin. Chir.*, vol. clv, p. 244, 1929.
- ⁹ Werenskiöld, B.: A Contribution to the Roentgen Diagnosis of Epiphyseal Separation. *Acta Radiol.*, vol. viii, p. 419, 1927.
- ¹⁰ Gold, E.: On the Treatment of the Separation of the Lower Epiphysis of the Femur. *ANNALS OF SURGERY*, vol. lxxxix, p. 577, April, 1929.
- ¹¹ Roberts, S. M.: Fractures of the Upper End of the Humerus. *Jour. Am. Med. Assn.*, vol. xcvi, p. 367, January 30, 1932.
- ¹² Poland, J.: Traumatic Separation of the Epiphyses. London, Smith, Elder and Company, 1898.
- ¹³ Hess, Alfred F.: Scurvy. Past and Present. J. B. Lippincott Company, Philadelphia and London, 1920.
- ¹⁴ Kahnt, E.: Epiphysenabrisz der Spina Iliaca Anterior Superior als Sportverletzung beim Schnellauf. *Zentralbl. f. Chir.*, vol. lvii, p. 2057, August 16, 1930.
- ¹⁵ Harrenstein, R. J.: Pseudoluxatio Coxæ durch Abreitzen der Femurepiphyse bei der Geburt. *Beitr. z. klin. Chir.*, vol. cxlvi, p. 592, 1929.
- ¹⁶ Linser, P.: Ueber die Entstehung und Behandlung Traumatische Epiphysenlösungen am Oberen Ende des Humerus. *Beitr. z. klin. Chir.*, vol. xxix, p. 351, 1901.
- ¹⁷ McFarland, Bryan: Traumatic Arrest of Epiphyseal Growth at the Lower End of the Tibia. *Brit. Jour. Surg.*, vol. xix, p. 78, July, 1931.
- ¹⁸ Watson, William L.: Fractures of the Lower Radial Epiphysis. *Arch. Surg.*, vol. xxiv, p. 492, March, 1932.
- ¹⁹ Klinefelter, M. L.: Quoted by Kurlander.²²
- ²⁰ Zadek, Isadore: Treatment of Epiphyseal Separation of the Lower End of the Radius. *Arch. Surg.*, vol. x, p. 969, May, 1925.
- ²¹ Speed, K.: Fractures and Dislocations. Lea and Febiger, Philadelphia and New York, 1916; personal communication to the author.
- ²² Patterson, W. J.: Separation of Lower Femoral Epiphysis. *Can. Med. Assn. Jour.*, vol. xxi, p. 301, September, 1929.
- ²³ Jones, and Lovett: Orthopedic Surgery. Second Edition. Wm. Wood and Company, New York, 1922.
- ²⁴ Willis, T. A.: The Slipping Femoral Epiphysis. *Jour. Bone and Joint Surg.*, vol. xi, p. 779, October, 1929.

RESULTS EPIPHYSEAL SEPARATION

- ²² Montgomery, A. H.: Separation of the Upper Epiphyses of the Radius. *Arch. Surg.*, vol. x, p. 961, May, 1925.
- ²³ Henderson, M. S.: Slipping Epiphysis of Head of Left Femur. *Surg. Clin. N. Amer.*, vol. x, p. 38, February, 1930.
- ²⁷ Haas, S. L.: The Experimental Transplantation of the Epiphysis. *Jour. Am. Med. Assn.*, vol. lxxv, p. 1965, December 4, 1915; *Ibid.*: Further Observation on the Transplantation of the Epiphyseal Cartilage Plate. Vol. lxxv, p. 958, May, 1931.
- ²⁸ Küttner, H.: Die Chirurgie der Peripheren Nerven. *Arch. f. klin. Chir.*, vol. clxxvii, p. 269, September 19, 1931.
- ²⁹ Löhr-Magdeburg: Epiphysenstörungen durch Erfrierungen. *Arch. f. klin. Chir.*, vol. clxxvii, p. 58, September 19, 1931.
- ³⁰ Speed, Kellogg: Longitudinal Overgrowth of Long Bones. *Surg., Gynec., and Obst.*, vol. xxxvii, p. 787, June, 1923.
- ³¹ Lapidus, P. W.: Epiphyseal Separation of the Lesser Femoral Trochanter. *Jour. Bone and Joint Surg.*, vol. xii, p. 548, July, 1930.
- ³² Kurlander, J. J.: Slipping of the Lower Femoral Epiphysis. *Jour. Am. Med. Assn.*, vol. xcvi, p. 513, February 14, 1931.
- ³³ Ferguson, Albert B., and Horworth, M. B.: Slipping of the Upper Femoral Epiphysis. *Jour. Am. Med. Assn.*, vol. xcvi, p. 1867, December 19, 1931.
- ³⁴ Friedrich, H.: Coxa Vara Epiphysarea. *Arch. f. klin. Chir.*, vol. clxxviii, p. 132, November, 1931.
- ³⁵ Esau: Angeborene Misbildungen der Glieder. *Arch. f. klin. Chir.*, vol. clxxviii, p. 371; December, 1931.
- ³⁶ Cutler, Condict W., Jr.: Fractures at the Condyles of the Femur. *ANNALS OF SURGERY*, vol. xcii, p. 551, February, 1931.
- ³⁷ Eikenbary, C. F., and LeCocq, J. F.: Separation of Upper Femoral Epiphysis. *Northwest Med.*, vol. xxx, p. 22, January, 1931.
- ³⁸ Madlener, M. J., and Wienert, B.: Beitrag zu den Olecranonbrüchen unter Besonderer Berücksichtigung der Spätresultate. *Arch. f. klin. Chir.*, vol. clxxviii, p. 576, January, 1932.
- ³⁹ Nussbaum, A.: Funktionelle Neubildung im Arthritischen Gelenk oder Spätfolge einer Epiphysenlösung. *Zentralbl. f. Chir.*, vol. lv, p. 2054, August 18, 1928.
- ⁴⁰ Driver, Johannes: Subchondrale Knochennekrosen und Pathologie der Funktion. *Arch. f. klin. Chir.*, vol. clxxvi, p. 640, October, 1931.
- ⁴¹ Muller, W.: Spätfolgen von Epiphysenlösungen am Oberen Femurende. *Beitr. z. klin. Chir.*, vol. cxi, p. 705, 1927.
- ⁴² Nussbaum, A.: Spätfolgen der Epiphysenlösungen am Oberen Femurende und Beziehungen zu Chondromen und zur Osteitis Fibrosa. *Arch. f. Orthop.*, vol. xxv, p. 323, July 28, 1927.
- ⁴³ Walter, H.: Spätfolgen der Epiphysenlösungen am Oberen Femurende und Beziehungen zu Chondromen und zu Osteitis Fibrosa. *Arch. f. Orthop.*, vol. xxvi, p. 103, 1928.
- ⁴⁴ Roegholt, M. N.: Der Einfluss der A, B, C, D Vitamine und der Elementa Ca und P auf die Heilung von Knochenbrüchen. *Arch. f. klin. Chir.*, vol. clxxviii, p. 782, January, 1932.
- ⁴⁵ Speed, Kellogg: Growth Problems Following Osteomyelitis of Adolescent Long Bones. *Surg., Gynec., and Obst.*, vol. xxxiv, p. 469, April, 1922.
- ⁴⁶ Harbin, M., and Zollinger, R.: Osteochondritis of the Growth Centers. *Surg., Gynec., and Obst.*, vol. li, p. 145, August, 1930.
- ⁴⁷ Griswold, A. S.: Early Motion in Treatment of Separation of the Lower Femoral Epiphysis. *Jour. Bone and Joint Surg.*, vol. x, p. 75, January, 1928.
- ⁴⁸ Conwell, H. Earle: Fractures of the Surgical Neck and Epiphyseal Separations of Upper End of Humerus. *Jour. Bone and Joint Surg.*, vol. xxiv, p. 508, July, 1926.
- ⁴⁹ Vadsten, O.: Traumatic Separation of the Epiphysis of Trochanter Minor. *Ugesk. f. Læger*, vol. xciii, p. 30, January 8, 1931.

FRACTURES OF THE HEAD AND NECK OF THE RADIUS

BY JOHN V. BOHRER, M.D.

OF NEW YORK, N. Y.

THE frequency of fracture of the proximal end of the radius, as compared with other fractures about the elbow, is approximately 3 per cent. It is, therefore, not a rare fracture; neither is it a common one. There have been 420 fractures about the elbow admitted to the Children's Fracture Clinic at Bellevue Hospital in the past ten years. Of this number only fourteen were of the proximal end of the radius.

This fracture is caused by both direct and indirect violence. In children it is about equally divided, while in adults direct violence is more common.

Diagnosis, as a rule, is quite simple. There is a history of either direct or indirect violence. The physical findings are: A swelling about the elbow, point tenderness over the head of the radius, normal relationship of the epicondyles and olecranon; crepitus is not usually present. The arm is held in partial flexion and semipronation. Motion about the elbow in any direction is painful. This is especially true of rotation. (Usually flexion and extension are not painful except in extreme position.) If the forearm is passively rotated, the head of the radius does not rotate with it. Pain and swelling over the dorsum of the hand frequently occur.

By careful examination one can usually make an accurate diagnosis; but the final and definite diagnosis must depend upon X-ray examination. X-ray pictures taken in two planes will determine the presence of and the particular type of fracture.

For purposes of treatment these fractures may be divided into three groups. *The First Group*.—Includes simple fractures without displacement of the fragments. It is generally agreed that this type of fracture should be treated conservatively. The arm is placed in moderate flexion with the hand in complete supination, in a posterior molded plaster splint, and held in this position for two weeks. This splint should be removed at intervals and active motion instituted, then replaced. At the end of two weeks the splint is permanently removed. The elbow is then baked and massaged. If so treated the results are universally good.

The Second Group.—Includes simple fractures with displacement of fragments, where the orbicular ligament is not badly damaged and where the fracture line does not involve the articular surface. These fractures should be operated at once, the fragment replaced in its normal position and held there by suture of the ligaments and muscles, or by the use of a band of fascia lata. The forearm must then be so placed as to best maintain this position, which can usually be accomplished by moderate flexion and semipronation. With the arm firmly held in this position by an assistant, the

FRACTURES OF THE HEAD OF THE RADIUS

wound is closed and a posterior molded plaster splint applied. The treatment then followed is the same as that given the cases in Group One.

The Third Group.—Is composed largely of the comminuted and badly displaced fractures which cannot be satisfactorily replaced. Resection of the head in these cases is imperative. A chip fracture of the head, which does not rotate in the lesser sigmoid cavity of the ulna, *i.e.*, a small lateral fragment, may be dealt with by simple removal and repairing of the orbicular ligament.

The growth of bone in children, which is usually a great adjunct and which in most fractures may be relied upon to correct deformity, cannot be depended upon to the same degree in fractures of the upper end of the radius. It has been a source of great disappointment to us to find a marked tendency to proliferative periostitis in both operated and non-operated cases, with a resultant synostosis between the radius and ulna. The immediate post-operative results usually are very good; flexion and extension readily return to normal. Rotation, which is a most important function of the elbow-joint, is also satisfactorily restored. In some of these cases the follow-up shows a gradual thickening of the proximal end of the radius, beginning as a productive periostitis, causing a gradual loss of rotation which finally becomes complete and due, of course, to a synostosis of the radius and ulna. This condition is not easily corrected, as was shown by one of our earlier cases in which the callus, together with the involved upper third of the radius, was carefully resected. Full rotation was restored only to be again completely lost by reformation of the resected portion and more callus, causing a recurrence of the synostosis.

In judging end-results in fractures of the head and neck of the radius, there are four major considerations, *viz.*: (1) Pain. (2) Stability of the elbow-joint. (3) Function. (4) Anatomical deformity. All, of course, are interrelated, especially pain and stability. Pain is, however, the greatest disability from the patient's point of view. It is usually in direct proportion to instability, so in choosing the type of treatment for a given fracture, these two considerations must receive the greatest attention.

Function.—Since the head of the radius enters into two distinct joints, it naturally contributes to both functions, *viz.*: flexion and extension and supination and pronation of the forearm. Fortunately, in fracture of the head and neck of the radius, flexion and extension are seldom limited. However, it occasionally occurs from excess callus or the formation of a loose body which locks the joint and prevents this function. Rotation, on the contrary, a most useful movement, is where we find most of our loss of function. This is usually due to synostosis of the radius and ulna, in the region of the fracture. It is most difficult to prevent and, indeed, in some cases that have a tendency to prolific callus formation, it is impossible. In order to avoid this disturbance, where open operation is done, extreme care should be exercised to remove all spicules of bone and shreds of periosteum.

The end of the radius should be smoothed off and the orbicular ligament carefully repaired.

In spite of these precautions, synostosis, with complete loss of rotation, occurred in 50 per cent. of the children operated upon for removal of the head of the radius. In none of these cases could a satisfactory replacement be accomplished. It is, however, surprising how this loss of function is compensated by the rotators of the arm and scapular muscles.

Anatomical deformity is, fortunately, not very great in this fracture. An increased carrying angle of the forearm is always found and is practically the only deformity.

In operated cases the prognosis cannot be made from inspection of the histories and operative findings, since very similar cases give opposite results. For instance, "G. Y.," a girl of six, had a minimum of trauma. She fell while roller-skating. She was operated promptly by Bohrer, who used the same technic and same post-operative treatment as in the case of "J. S.," a girl of nine, who also fell while roller-skating. The X-ray pictures were quite comparable in the two cases, yet in "G. Y." the radius and ulna became synostosed and she lost her rotation, while "J. S." resulted in normal restoration of function.

This is also true in cases operated by Beekman. "W. D.," a boy aged ten years, operated seven days after the accident, resulted in normal restoration of function; while "R. M.," a boy of ten, operated ten days after the accident, resulted in synostosis of the radius and ulna.

From observation of these reported cases over a prolonged period of time and a review of the literature, I have come to the following conclusions:

(1) Fracture of the head and neck of the radius, in children, should be treated conservatively unless there is marked displacement of the fragment.

(2) In cases of marked displacement of the fragment, early operation with replacement of the fragment is preferable to resection.

(3) If resection is done, about 50 per cent. will develop synostosis of the radius and ulna in the resected area. This synostosis occurs several months after operation.

(4) In resected cases a stable, non-painful joint may be expected.

(5) Flexion and extension are seldom limited.

(6) In resected cases an increased carrying angle always develops, apparently from a lack of growth at the proximal end of the radius.

(7) In adults: Simple fracture with displacement, even if the fracture line involves the articular surface, should be treated conservatively.

(8) In operative cases resection of the entire head of the radius is the operation of choice. A stable, non-painful joint, without loss of function, may usually be expected.

SUMMARY AND ANALYSIS OF CASES

(1) Of twenty cases which form the basis of this report, twelve were treated conservatively. Those with slight displacement have excellent results.

FRACTURES OF THE HEAD OF THE RADIUS

Those with marked displacement have loss of rotation and some loss of flexion and extension.

(2) Of the children's cases, five were operated for resection of the head of the radius. Two recovered full function permanently; three had complete function when discharged from the hospital, but over a period of several months, rotation was lost from productive periostitis followed by synostosis of the radius and ulna.

(3) Of the children's cases nine were treated conservatively. Three of these had severe injuries with displacement or comminution of the head of the radius; two became synostosed with loss of rotation; one recovered complete function. The remaining six, with slight trauma, recovered complete function.

(4) One adult case, operated for resection of the head of the radius, resulted in complete restoration of function. Another adult case, where replacement of the fragment was done, resulted in loss of rotation and 20 per cent. loss of flexion and extension.

(5) Of the adult cases, four were treated conservatively. Three recovered complete function; while the fourth, whose fracture involved the joint surface, has limited motion in all directions.

LITERATURE.—There is considerable difference of opinion among authors on the advisability of treating this fracture operatively or conservatively.

Culp² reports four cases, all adults, in which the fractured head of the radius was removed. There was complete restoration of function, with minimum loss of time.

The conclusions of Key's³ excellent paper are: "Certain fractures of the upper end of the radius should be treated conservatively, others should be treated by immediate operation with either removal or replacement of the head, and others should be treated expectantly and the head removed later if necessary. In children, the displaced head of the radius can be replaced by open operation and a practically normal elbow and forearm may be expected.

"After early removal of the head of the radius, a satisfactory but not a normal elbow and forearm may be expected.

"Traumatic arthritis is the result of function in a disorganized joint, and late removal of the head of the radius after the arthritis has developed will not as a rule cure the arthritis."

E. Lassen,⁴ of Copenhagen, believes in conservatism. He reported seventy-one cases. Sixty-three were treated conservatively. Subsequent examinations were done in fifty-seven cases, including the eight operative cases. Thirty-one of the fifty-seven were good functional results; moderately good in fourteen, and poor in four. (The operative cases did not give good results.) Open operation was used only in grave fractures and, with but a single exception, was performed at a late date.

Pfab⁵ reports fifty cases. Direct violence in twenty-nine; indirect violence in twenty-one. Only in those cases where the injury was less severe did he get a perfect result.

He resected eight cases, in three of which there was complete restoration of function.

Philips and Gallard⁶ report five cases of fracture of the neck of the radius, in which the Röntgen-ray examination revealed: "A fracture involving the posterolateral corner of the proximal juxta epiphyseal portion of the diaphysis of the right radius, the fracture entering the epiphyseal line, thus chipping off a pyramidal piece of bone measuring about one-half inch on a side." Apposition of the fragments was perfect except in one case.

All were treated conservatively with the arm held in Jones' position. Each case resulted in complete recovery of function.

Bohler⁷ states: "If the head of the radius is fissured in its long axis, or is broken off without any displacement, it is treated by the application of a plaster bandage which is left on for four weeks, and in the same manner as the fractures of the olecranon. If the head is splintered and the fragments are displaced, or when the head is broken and dislocated, it is very seldom possible to obtain a good position. The rotations of the forearm are either quite limited or disappear altogether. In these cases, it is therefore best to remove the head. The incision is made on the lateral side but should not reach too far anteriorly, because small branches of the radial nerve are apt to be injured. A plaster case is given for two weeks."

Scudder⁹ states that in fractures of the head and neck of the radius, in children: "The elbow should be placed in the acutely flexed position with forearm in complete supination after manipulative pressure and traction on forearm. Usually after ten days guarded painless motion may be begun and along with massage will succeed in securing almost perfect function of the joint."

In adults: "Excepting in linear fractures without much if any displacement, a complete removal of the head of the radius immediately after the injury should be done. All fragments should be carefully removed. Avoid injury to the joint capsule and synovial membrane. Keep the annular ligament intact. Close the wound tight. In about a week or less begin active guarded movements.

"In operating, the fragments of bone should be removed, and when the exact conditions are seen a complete resection of the head of the radius done. Operation is indicated with a complicating irreducible dislocation of radius or ulna or both.

"Gentle massage and passive motion and attempts at active motion should, within four to eight weeks, result in approximately normal elbow movements."

BIBLIOGRAPHY

- ¹ Siris: Elbow Fractures and Dislocations. Surg., Gyn. and Obst., vol. xl, p. 665, 1925.
- ² Culp: Treatment of Fractures of Head of the Radius. Internat. Clin., vol. ii, pp. 208-212, January, 1930.
- ³ Key: Treatment of Fractures of the Head and Neck of the Radius. J. A. M. A., vol. xcvi, No. 2, p. 101, January 10, 1931.
- ⁴ Lassen, E.: Fractures of the Head and Neck of the Radius. Hospitalstid., vol. lxxii, p. 909, September 5; p. 919, September 12, 1927.
- ⁵ Pfab, B.: Treatment of Fractures of the Head of the Radius. Deutsch. Ztschr. f. chir., vol. ccxvi, pp. 351-356, 1929.
- ⁶ Philips and Gallard: Jour. Am. Med. Assn., vol. lxxxviii, pp. 1318-1319, April 23, 1927.
- ⁷ Böhrer: Treatment of Fractures. English Edition, p. 84.
- ⁸ Buxton: Fractures of the Head and Neck of the Radius. Clin. J., vol. lvi, pp. 25-28, January 19, 1927.
- ⁹ Scudder, C. L.: The Treatment of Fractures. Tenth edition, pp. 375-377.

END-RESULTS OF CARPAL-SCAPHOID FRACTURES

BY LEEMAN E. SNODGRASS, M.D.

OF PHILADELPHIA, PA.

FROM THE SURGICAL DISPENSARY OF THE EPISCOPAL HOSPITAL

THE subject of this paper is a study of end-results of fracture of the carpal scaphoid, together with some remarks on the incidence of the fracture and on the probable manner of its production. This work takes origin in an analysis of case reports (with a study of the X-ray films and end-result examinations) in the Surgical Dispensary of the Episcopal Hospital of Philadelphia; from a dissecting-room study of the anatomy involved; and from a partial review of the literature.

The cross-index file in the Röntgen-ray department of this hospital for an approximate five-year period (January 19, 1925 to September 2, 1930), contains 125 instances of fracture of the carpal scaphoid. In about the same period of time, the following conditions were noted:

| | | | |
|---------------------------------|-----------|-----------------------------------|----------|
| Fracture of the phalanges..... | 716 cases | Luxation of the semilunar..... | 19 cases |
| Fracture of the metacarpals.... | 564 cases | Luxation of the os magnum..... | 1 case |
| Fracture of the os magnum.... | 2 cases | Luxation of the scaphoid..... | 1 case |
| Fracture of the pisiform..... | 3 cases | Subluxation distal row of carpus. | 1 case |
| Fracture of the semilunar..... | 12 cases | Luxation of the wrist..... | 9 cases |
| Fracture of the trapezium..... | 3 cases | Kienboch's disease..... | 1 case |
| Fracture of the trapezoid..... | 1 case | Osteomyelitis of the carpus..... | 2 cases |

These figures place fracture of the carpal scaphoid third in order of frequency in fractures of the bones of the hand and wrist and demonstrate again that congenital anomalies, new growths and infections involving the bone in this region are rare.

The 107 cases of fracture of the carpal scaphoid used in this study, consecutive so far as it was possible to have them so, included ninety-five males and twelve females. Table I summarizes this group of cases which included those with and without follow-up study.

In forty-six of the 107 cases, an end-result study was impossible. In the remaining sixty-one patients, the final result was known, and in forty-eight of these, end-result X-ray films were available for study. The interval in the follow-up was above six years in seven; six years in eight; five years in three; four years in ten; three years in six; two years in fifteen and one year and under in twelve.

The end-results were classified as good, moderately good and poor. A good result was regarded as one in which all movements were normal, the grip had good power and there was no pain; a moderately good result was regarded as one having some pain but a good grip and normal movement, and a poor result was signified by pain of a more definite character, a limita-

TABLE I

107 Cases of Fracture of the Carpal Scaphoid (Ninety-five Males and Twelve Females)

| Age† | Operative Cases | Old Cases | Causes of Fracture (Aside from a Fall on the Outstretched Hand to a Standing Level) | Associated Injuries | Site of Fracture* |
|------------|-----------------|------------|--|---------------------------|------------------------|
| Age 10 | 1 | 5 (all | 1 struck on wrist by | 8 dislocations of semi- | 73 middle of bone (all |
| 2nd decade | 24 | from the | hammer | lunar (all volar) | transverse) (7 in- |
| 3rd decade | 32 | group of | 1 struck on wrist with | 1 fracture of semilunar | complete) |
| 4th decade | 30 | old cases) | iron bar while hand | (not dislocated) | 7 distal end (5 in re- |
| 5th decade | 7 | two | was in midair | 1 dislocation of distal | gion of tuberosity |
| 6th decade | 7 | weeks) | 2 crushing injuries | carpal row | and 2 through distal |
| | | | 2 fell from motor trucks | 5 fractures of distal end | radial corner) |
| | | | 2 from backfire in | of radius (3 of which | 2 in proximal end |
| | | | cranking an engine | were comminuted) | 2 along posterior bor- |
| | | | 1 from lifting a heavy | 1 chauffeur's fracture | der |
| | | | object | 1 incomplete fracture | 4 comminuted |
| | | | 8 fell a distance equal | of radial head | 6 had fragments dis- |
| | | | to or exceeding their | 1 Colles' fracture | located (in every |
| | | | height | 1 fracture of the cun- | case in volar direc- |
| | | | | eiform | tion) |
| | | | | 1 fracture of proximal | 2 had two fractures |
| | | | | end of first metacarp- | in bone (one in mid- |
| | | | | pal | dle and one in dis- |
| | | | | 1 fracture of ulnar sty- | tal end in each case) |
| | | | | loid | |
| | | | | 1 compound fracture | |
| | | | | both bones of forearm | |
| | | | | at the junction | |
| | | | | of the middle and | |
| | | | | lower thirds with a | |
| | | | | sprain fracture of the | |
| | | | | ulnar styloid and the | |
| | | | | cuneiform | |

* The site of fracture in the bone is given in the above tabulation in those cases where the film was at hand or where the X-ray report stated definitely the location of the fracture.

† Age is given in Tables I and II at time of fracture and when definitely known.

tion of movement in the wrist-joint, and a weakened grip. With this classification in mind, forty were found to be good results, ten were moderately good and eleven were poor. This group is summarized in Table II.

The two patients with comminuted fractures who fell in the end-result group obtained a good result, one with operation and one without. In two fractures with displacement of fragments, in each case the distal fragment being the one displaced, the result was good, but the end-result X-ray film showed slight deformity of the scaphoid in one. The seven patients with fracture in the distal end and the two with fractures along the posterior border had good results. Unfortunately, the two patients with fractures in the proximal end and with two separate fractures in each bone belonged to the group of cases without end-result study. Four of the seven cases with incomplete fractures were in the end-result group and all showed an excellent result clinically, and by X-ray examination.

There were no bipartite scaphoids found in this series, nor was a single case of cavity formation found. Likewise, there were no instances of ex-

CARPAL-SCAPHOID FRACTURES

TABLE II

End-Results in Sixty-one Patients with Fractured Carpal Scaphoid

| Ages in Years | | Patients Operated on | Old Fractures (of More Than 2 Weeks' Duration) | Associated Injuries |
|---------------|--|----------------------------|--|--|
| Good | 2nd decade = 13 | 2 | 5 | Three volar dislocations of semilunar |
| Total = 40 | 3rd decade = 11 | | | One fracture of distal end of semilunar |
| | 4th decade = 9 | | | One sprain fracture of ulnar styloid |
| | 5th decade = 6 | | | |
| | 6th decade = 1 | | | |
| Mod. | 14, 20, 21, 25, 27, | 4 | 4 | One compound fracture of both bones of forearm with a fracture of ulnar styloid and cuneiform bone |
| Good | 29, 38, 48, 50, | | | One sprain fracture of lower posterior border of radius |
| Total = 10 | and 51 years, respectively | | | |
| Poor | 17, 18, 18, 19, 21, | 3 | 6 | Two volar dislocations of the semilunar |
| Total = 11 | 21, 23, 33, 36, 39, and 67* respectively | | | |

* The 67-yr.-old patient was fractured an unknown number of years previously.

trinsic synostosis to the articular margin of the radius as described by Bizarro.² The increased percentage of associated injuries in the poor and moderately good result groups was thought to be significant only of the increased force which acted.

In discussing this series of fractures, it can be pointed out that fracture of the carpal scaphoid is a fracture occurring in the first half of life and that it is comparatively rare above the age of fifty. The statement sometimes made that age has little to do with the prognosis in this type of fracture does not convey all of the truth.

The question of correlation between the clinical end-result and the end-result X-ray film has been mentioned in the literature and it is answered in the negative in the case of the patient, V. G., aged thirty-nine years, having a three-year-interval follow-up. At the age of thirty-six years, this man fell to the ground and sustained what was diagnosed as a slight subperiosteal fracture of the scaphoid. His end-result X-ray film, taken in August, 1931, showed an excellent result with no sign of the previous fracture, but on clinical examination, crepitus could be felt in this wrist and there was some weakness in his grip. This case, however, is the only one classed as a poor result in which the X-ray findings were not what one would expect to find with opinion based on the clinical examination.

In the group of moderately good results, one man, F. T., aged fifty-seven, showed non-union with arthritis on X-ray examination but his grip was powerful, and radial deviation and flexion and extension only slightly limited, six years after the fracture. Another

patient, S. B., aged twenty-eight years, fourteen months after fracture, showed an excellent union in the X-ray film with no line of fracture visible, but on clinical examination extreme dorsiflexion was painful.

In the group of good results, a patient, H. S., aged thirty-one years, after two and one-half years' interval, showed a good clinical result but the X-ray film showed non-union without arthritis. A patient, R. L., aged twenty-six years, after a three-year interval since fracture showed a good clinical result, but X-ray examination revealed an ununited fracture with considerable atrophy of fragments. There were two patients classified as good results in spite of the fact that they had very slight pain when using the wrist in a certain fashion; one complained that he felt pain when he walked on his hands and the other had pain only in pitching a baseball. The above-mentioned cases taken from each of the three end-result groups seem to indicate an occasional discrepancy between the end-result clinical and Röntgen examinations.

The rarefaction of the scaphoid and other carpal bones following this fracture may be due, in part, to the direct injury, and, in part, to the atrophy of disuse caused by the pain on movement or to the splint used in the course of treatment. This brings us to a very live question which is involved in any study such as this, *i.e.*, Is traumatic arthritis an example of hypertrophic or atrophic arthritis? A patient, E. F., fell at the age of fourteen years and sprained his wrist. Nineteen years later, at the age of thirty-three years, he came to the Dispensary complaining of pain in his wrist. Clinical examination showed some limitation of movement in all directions in the wrist with slight grating. The X-ray examination showed non-union in an old fracture of the carpal scaphoid with hypertrophic osteoarthritis of the distal border of the radius. Another patient, J. G., aged eighteen years, fell two years and seven months before, and sustained a transverse fracture in the middle of the scaphoid bone with volar dislocation of the semilunar. He was operated on five months after the injury and one-half of the scaphoid and the semilunar were removed. His last clinical examination (1931) showed limitation of dorsiflexion and of radial and ulnar deviation, with some weakness of the grip, and with a complaint of pain in bad weather. Röntgen examination showed traumatic arthritis of the wrist with lipping. In these two patients, one sees the development in young adult life of a disease ordinarily found in older individuals. In all other cases in this series showing signs of arthritis, the findings were those of the atrophic type, *i.e.*, with limitation of motion and rarefaction, loss of sharp bone outline, and absence of lipping in the röntgen examination.

One might think of the wrist-joint as being functionally older than many other joints in the body for it is nearly always in motion in our waking hours. A. W. Meyer^{7, 8, 9} has written very interestingly of use degeneration in normal joint cartilage. This idea of the individuality of joints seems to gain support from studies by D. H. Kling⁶ on the Nature and Origin of Synovial Fluid, who wrote: "The development of the membrane and of the fluid is different in various joints. The secretory element is best developed in the knee-joint and less well developed in the wrist and tarsal joints. The primary response to inflammation and irritation of the knee is, therefore, effusion; that of the wrist, infiltration and pannus formation."

The treatment of recent cases (two weeks old or less) in this series, has been by a straight volar splint from the base of the fingers to the elbow for not less than five weeks and longer if necessary. The splint is reapplied once a week. Berlin¹ dissected sixty wrists and thought that some of the flexor tendons with the transverse carpal ligament acted as a sling to hold the fragments of the scaphoid in closer apposition in moderate dorsiflexion, and that the attachment of the dorsal carpal ligament to the proximal two-thirds of the dorsal surface of the scaphoid made any other position but

CARPAL-SCAPHOID FRACTURES

dorsiflexion illogical. He advocated dorsal flexion to about 40 to 50 degrees with slight radial deviation. Böhler³ also advised dorsal flexion, using a dorsal plaster splint, and he is very optimistic over the prognosis even in old cases when this treatment is continued for a longer period. Speed¹⁰ advocated a position midway between flexion and extension.

Hosford⁵ reported nine good results out of twenty-six fractures and Burnett⁴ reported seventeen good results; thirteen fair, and seven poor. Both of these men used the dorsiflexed position. If a stiff wrist is anticipated, dorsiflexion seems to be the position of choice for splinting. In many of the old cases in adults, it should be remembered that one is dealing with an arthritis and while operation may be performed in the older cases, and seems to be indicated early in those cases with displaced fragments, the prognosis should be guarded.

The opinion may be ventured that fracture of the carpal scaphoid without displacement, in which splinting is instituted within a few days and continued for a period of from five to eight weeks, warrants an optimistic prognosis; certainly as optimistic as for intra-articular fracture elsewhere in the body.

A SUGGESTED MECHANISM IN THE FRACTURE OF THE CARPAL SCAPHOID

This discussion is concerned with the production of fracture of the carpal scaphoid in the ordinary manner, which is by a fall on the hand or by back-fire in cranking an engine. Forced hyperextension of the wrist is not considered here because it is probably not of common occurrence in falls on the hand. The weight of the body in the average fall is received on the muscular volar-superior surface of the hand. This statement is supported by two observations, the first of which is found in the occasional clear history of a fall forward on the hand where forced hyperextension would be unlikely; secondly, it seems reasonable to assume that the very capable protective mechanism which exists proximal to the wrist in the shoulder, elbow and proximal radio-ulnar articulations would be utilized to the limit before hyperextension occurred. In the shoulder-joint, this is composed of a possible 135 degrees of rotation of the trunk around the head of the humerus, combined with circumduction of 360 degrees, when the position of the hand is fixed and the radius and ulna are fixed on the humerus. After the force of the fall is taken up in the hand, the elbow-joint may relax, allowing the body to roll forward or backward of the coronal plane to the ground. Moreover, when the trunk is fixed on the head of the humerus, the humerus may still rotate 180 degrees around the head of the radius, and any or all of these movements may take place together.

The wrist-joint, of which the scaphoid forms somewhat less than half of the distal articular surface, is a biaxial diarthrosis allowing flexion and extension of about 50 and 75 degrees, and ulnar and radial deviation of about 40 and 25 degrees, respectively. Full ulnar and radial deviations, present only when the wrist-joint is in 180 degrees extension, become progressively less as the wrist goes into extension, until they are absent in hyperextension.

This is readily understood when it is remembered that the axis of rotation in ulnar and radial deviation is an antero-posterior line through the centre of the carpus, when the wrist is at 180 degrees extension, but which would change to a superior-inferior line through the centre of the carpus, were rotation possible when the wrist was hyperextended. But this is not the case, and if it were, then rotation in the wrist would be possible in three planes instead of two as it normally is, and the wrist would thereby become an enarthrosis with the movement polyaxial. This may be checked on the cadaver by taking the forearm, disarticulated at the elbow, with the hand fixed in radial or ulnar deviation, and gradually bringing the proximal end of the specimen up from a position of 180 degrees extension into hyperextension. While using all possible force to press down on the proximal end of the radius and, at the same time, attempting to hold it over into either ulnar or radial deviation, it will be found that the radius is rotated from distally, in the radiocarpal articulation, out of deviation into the mid-position. Again, with the forearm disarticulated at the elbow, the body weight of the investigator was thrown forcefully against the proximal end of the radius, with the hand fixed in radial deviation and as much extension as the deviation would allow. The result was a fracture of the radial styloid.

In the disarticulated specimen of the wrist-joint, it is apparent that the articulating surface of the joint is longer than it is wide; that it is incongruent in any other position except the one; and that in hyperextension it is locked in this position by the overhanging anterior lip of the articular surface of the radius. Furthermore, the flexor carpi ulnaris and the flexor carpi radialis when put under extreme tension, as in hyperextension, serve as ligaments to check movement in this joint.

In the dissected specimen of the wrist with only the intercarpal ligaments intact, it will be found that the bones of the proximal row of the carpus form an arch which is curved in two directions. It is convex on its radial and dorsal surfaces, respectively, and concave on its midcarpal and volar surfaces, respectively. It is noteworthy that the scaphoid bone comprises almost one-half of this arch of proximal bones and that the radial side of the arch is not segmented as it is on the ulnar side, where the osseous elements are divided into two separate bones (semilunar and triangular). The scaphoid is narrowed at its middle, and on the dorsal surface across its midportion is attached the dorsal carpal ligament, through which small blood-vessels enter the bone. At either extremity the arch rests on the multangulans and on the hamate, and is supported in its middle by the head of the capitate. The distal row of bones are firmly bound to each other and to the proximal ends of the metacarpals, and except in the case of the first metacarpal, may be considered as a unit for there is scarcely any movement between them. Their ligaments are very strong and dense. Force transmitted from the distal row of carpal bones, where most of the force from a fall on the hand probably originates, reaches the scaphoid by three routes; one through the capitate, which fixes the scaphoid against the articular surface of the radius;

CARPAL-SCAPHOID FRACTURES

one line of force on the radial side through the multangulans to the scaphoid on its distal end, and one on the ulnar side through the hamate, triangular and semilunar to the proximal end of the scaphoid. The semilunar is the keystone of this arch, which accounts for its rather frequent dislocation.

The structure maintaining this arch is the transverse carpal ligament and its position of importance in the explanation of these fractures and in the normal use of the hand has not been sufficiently recognized. This exceedingly strong ligament spans the concavity of the volar surface of the carpus and converts this concavity into a tunnel for the passage of the deep flexor tendons and median nerve. It is attached on the radial side to the tuberosity of the scaphoid, and to the scaphoid bone around the base of the tuberosity, and to the ridge on the volar surface of the greater multangular bone which lies just radially to the groove in the bone for the flexor carpi radialis tendon. On the ulnar side, it is attached to the triangular bone with an attachment passing to the pisiform and to the unciform process of the hamate bone. These four bony attachments protrude volarly and serve to accentuate the concavity anteriorly, of the proximal row of bones. It is interesting to note that the two strong flexors of the wrist pass directly over these bony prominences, and in the palm down position of the hand as in falling, lend support to them. The flexor carpi radialis lies directly against the volar surface of the tuberosity of the scaphoid, with its sheath much thickened at this point, and then passes in a groove on the surface of the greater multangular on its way to insertion in the proximal end of the second metacarpal. The flexor carpi ulnaris inserts on the pisiform which lies on the volar surface of the triangular, and then is continued to the hamate by the piso-hamate ligament and to the base of the fifth metacarpal. The pisiform bone is not of importance when discussing the proximal row of carpal bones as an arch in a superior-inferior direction. However, when considering the arch which these bones form in the antero-posterior (volar-dorsal) direction, the pisiform assumes new value for it supports the ulnar side of the arch when the hand is in the position which it assumes in transmitting pressure instead of tension, *i.e.*, in a fall on the hand, or in pushing with the hand, or in sustaining pressure from the backfire of an engine.

As the wrist moves into extension, the tendons of the flexors carpi ulnaris and radialis are put on the stretch and support this arch of the proximal row of bones. This seems to be an ingenious arrangement on the part of Nature, to transform the pressure of a fall into a tension in the tendons of the flexors carpi ulnaris and radialis, and so transfer the force all through the hand, from the base of the second metacarpal on the radial side and the base of the fifth metacarpal on the ulnar side, to the proximal row of carpal bones and the articular surface of the radius. The arrangement may be compared to an inverted suspension bridge in each tendon, where the head of the second metacarpal and the hamate and the base of the fifth metacarpal, serve as anchorage for the two tendons, and the pisiform against the triangular on one side, with the tuberosity of the scaphoid and the ridge on the greater

multangular on the radial side, acting as suspension towers which hold up the arch of the carpus. The transverse carpal ligament prevents the tendency to spread apart of the extremities of the arch when pressure is applied to its convexity.

When one falls on his hand, the semilunar is pushed straight downward, sometimes slipping out into volar dislocation, while the triangular and the scaphoid are forced lateralward. The middle of the scaphoid is the weakest point in this arch of the proximal bones for three reasons; first, it is thinnest in its middle; secondly, the cortex, which is the only hard bone found in any of the carpals (the interior being cancellous), is perforated by small vessels in this area; and thirdly, the scaphoid is the largest and longest bone in the proximal row, and is not segmented, and therefore is less able than the osseous elements on the ulnar side of the wrist to withstand a fracturing force. The proximal end of the scaphoid is held against the articular surface of the radius by the capitate. The transverse carpal ligament, by its attachment to the distal end of the scaphoid and to the greater multangular to which the scaphoid is also attached, resists this lateral expansion of the carpus and fracture in the middle of the bone is the result.

Due to its position, injury to the tendon and its sheath of the flexor carpi radialis where it passes over the tuberosity of the scaphoid may account for some of the pain in these wrists, where the X-ray examination is negative and where the clinical examination is otherwise negative.

BIBLIOGRAPHY

- ¹ Berlin, David: Position in the Treatment of Fractures of the Carpal Scaphoid. *New England Jour. Med.*, vol. cci, pp. 574-579, September 19, 1929.
- ² Bizarro, A. H.: Traumatology of the Carpus. *Surg., Gynec., and Obst.*, vol. xxxiv, No. 5, May, 1922.
- ³ Böhler, Lorenz: The Treatment of Fractures. William Mandrich, Vienna, 1929. English translation by M. E. Steinberg, M.D.
- ⁴ Burnett, Joseph H.: Fractures of Carpal Scaphoid. *New England Jour. Med.*, vol. cc, pp. 126-127, January 17, 1929.
- ⁵ Hosford, John P.: Prognosis in Fractures of the Carpal Scaphoid. *Proc. Roy. Soc. Med. (Sect. Surg.)*, vol. xxiv, pp. 92-94, May, 1931.
- ⁶ Kling, David H.: The Nature and Origin of Synovial Fluid. *Arch. Surg.*, vol. xxiii, p. 543, October, 1931.
- ⁷ Meyer, A. W.: Evidences of Attrition in the Human Body. *Anat. Rec.*, vol. xxv, p. 142, 1923.
- ⁸ Meyer, A. W.: Further Evidences of Attrition in the Human Body. *Anat. Rec.*, vol. xxvii, p. 211, 1924.
- ⁹ Meyer, A. W.: The Minuter Anatomy of Attrition Lesions. *Jour. Bone and Joint Surg.*, vol. xiii, No. 2, p. 341, April, 1931.
- ¹⁰ Speed, Kellogg: Traumatic Injuries of the Carpus, p. 163. D. Appleton and Company, New York, London, 1925.

RECONSTRUCTIVE OPERATION FOR NON-REDUCIBLE FRACTURES OF THE HEAD OF THE HUMERUS

BY LAURENCE JONES, M.D.

OF KANSAS CITY, MISSOURI

FROM THE SURGICAL SERVICE OF MENORAH HOSPITAL

THERE are no fractures in which the prognosis for recovery of function is more grave than in those about the surgical neck of the humerus, when accompanied by fragmentation and gross displacement. If dislocation of the fractured head is present, the outlook is even more gloomy.

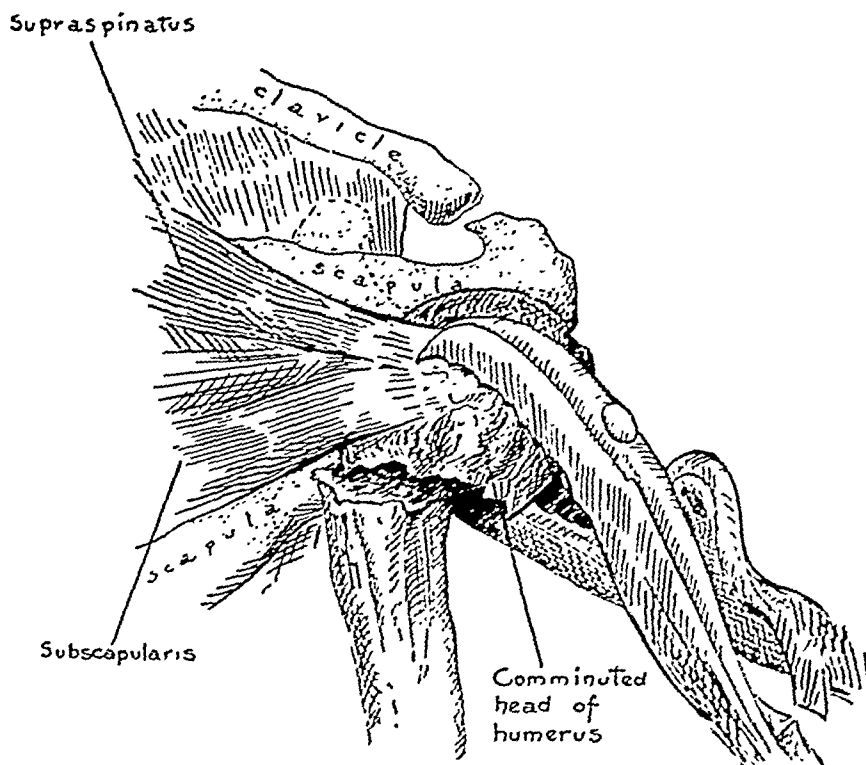


FIG. 1.—Diagrammatic illustration of the first step in removal of the fractured head and the attached short rotators of the humerus.

Although this particular sub-group probably does not contain more than 2 per cent. of the total number of fractures in this region, the poor results of treatment impel me to report an operative procedure first used by me in 1926, the final results of which have exceeded my most sanguine expectations.

The literature abounds with analyses of end-results of varying forms of treatment. A quotation from Santee¹ affords an excellent and characteristic example. "End-results in these cases (the severe fractures requiring operative reductions and excisions of the head) are little different from those cases in which no operation was done. Fractures about the neck of the humerus occur mostly after mid-life; disability is marked and prolonged."

The operation about to be described is not suitable for gross defects involving the entire upper third of the humerus. Various procedures using bone-grafts have been reported by De Courcy Wheeler,² and Albee³ for this

type. One quotation from Albee³ should be noted: "From the stand-point of definitive treatment such cases have been regarded as quite hopeless. The arm is merely a cumbersome appendage which might, occasionally, be swung laboriously from one side to the other in the performance of simple clumsy acts, but which, from a practical stand-point, is useless."

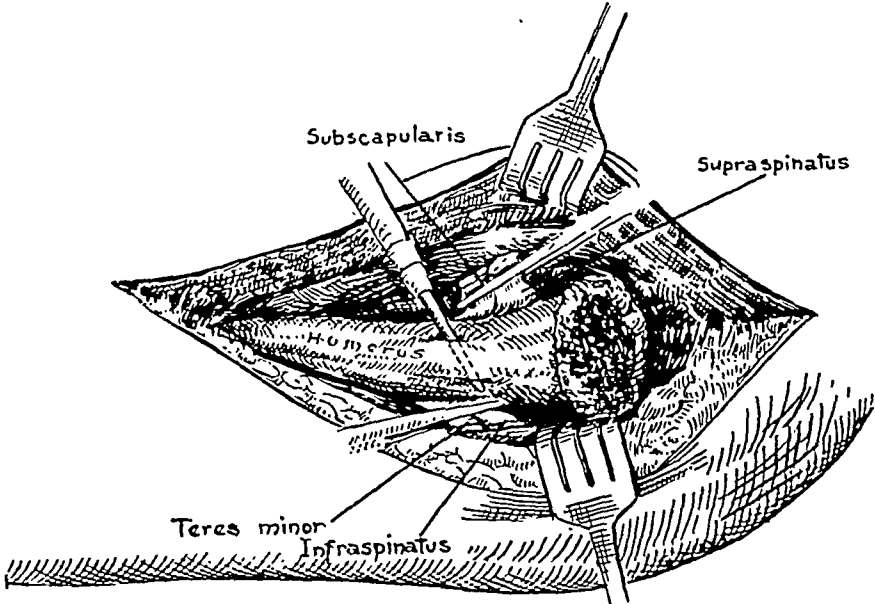


FIG. 2.—Demonstrating tendons of the four rotators and preparation of site of transplantation.

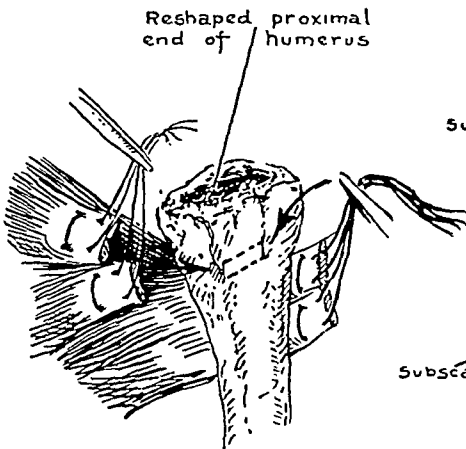


FIG. 3.

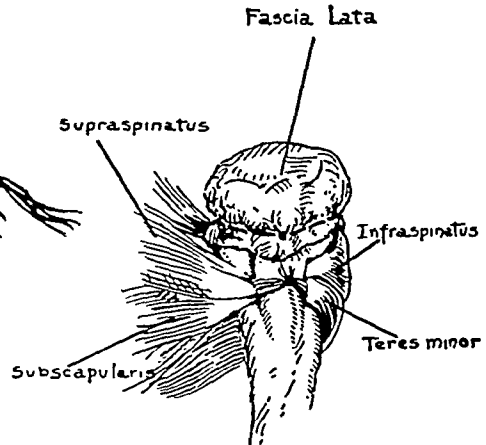


FIG. 4.

FIG. 3.—Diagrammatic illustration of reshaped head and tendinous preparation.
FIG. 4.—Diagram illustrating the application of the fascial flap and the completed muscle transplants.

Murphy,⁴ in several cases, removed the fractured head, reshaped it and then drove a nail at an angle through the shaft into the head. He accompanied this by a fat or fascial transplant.

Present-day treatment has been limited to resection of the head, or arthrodesis. Where fusion of the humerus to the glenoid is performed, scapular motion sometimes compensates very well for the lost shoulder-joint motion

FRACTURE OF HEAD OF HUMERUS

but abduction is limited to twenty degrees at most and there is almost complete loss of rotatory movement.

Description of the Operative Procedure.—There are two points to be considered before the operation. One, the preparation of an aeroplane splint designedly about two inches shorter than the normal upper arm length, adjusted at about a 50° angle from the vertical, the other, a special operative assistant, seated at the side of the table, to control the arm through manipulation of the elbow. This is absolutely essential to proper exposure. From a previously prepared area on the thigh, a circular strip of fascia lata, measuring

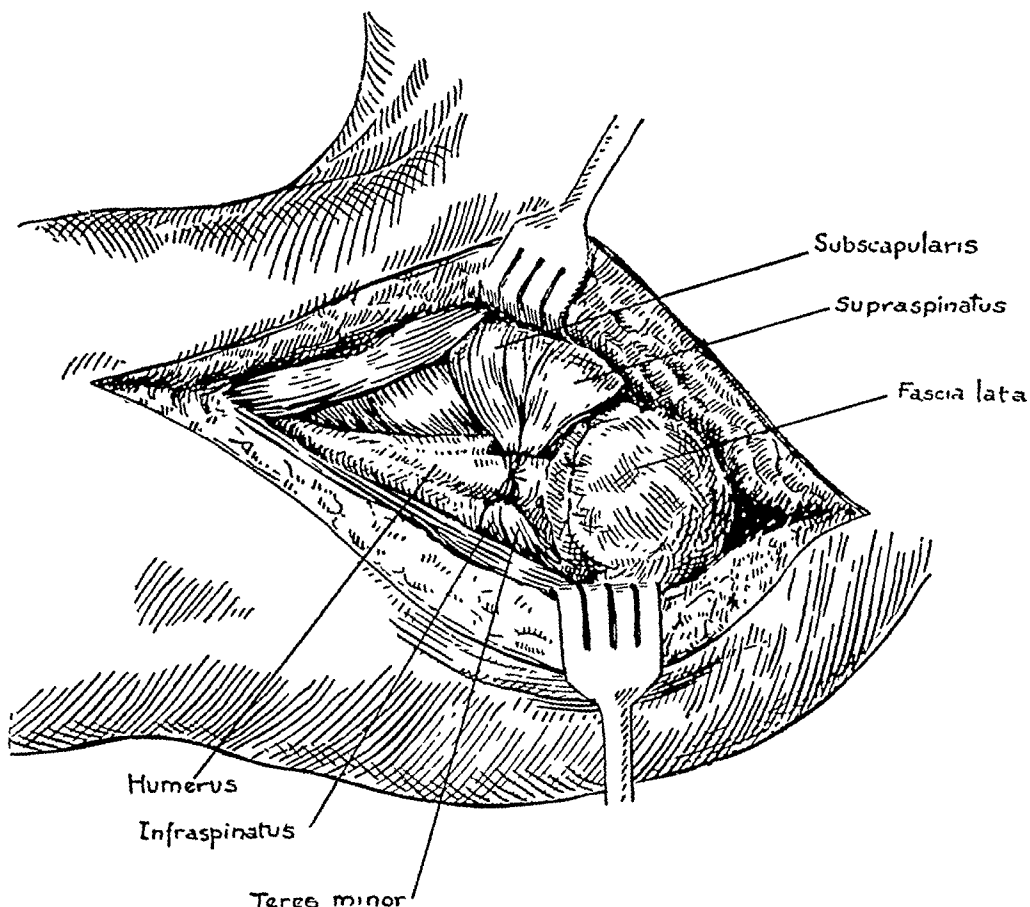


FIG. 5.—Appearance of operative field prior to closing.

about three and one-half inches in diameter, is secured. It is then placed in saline solution. An eight-inch lateral incision is made, starting one and one-half inches above the acromion processes, and extending down the arm.

At the present time, I am of the opinion that an anterior approach would be a better one. The incision is deepened, the joint capsule incised and the fractured head of the humerus exposed. The head is seized with large bone forceps, separated from the shaft and surrounding structures, and forcibly drawn out of the wound. Two grooves are made in the shaft of the bone, about one-half inch apart, and about one inch below the upper end of the shaft and connected to each other by a small tunnel.

This was the procedure used in the second case from which the drawing was made.

The operation was performed with slight modifications each time.

To secure the closest resemblance to the normal anatomical position, two drill holes should be made, one antero-posteriorly, the other laterally.

The short rotators attached to the head: namely, the supraspinatus, the subscapularis, the infraspinatus, and the teres minor, are cut close to their

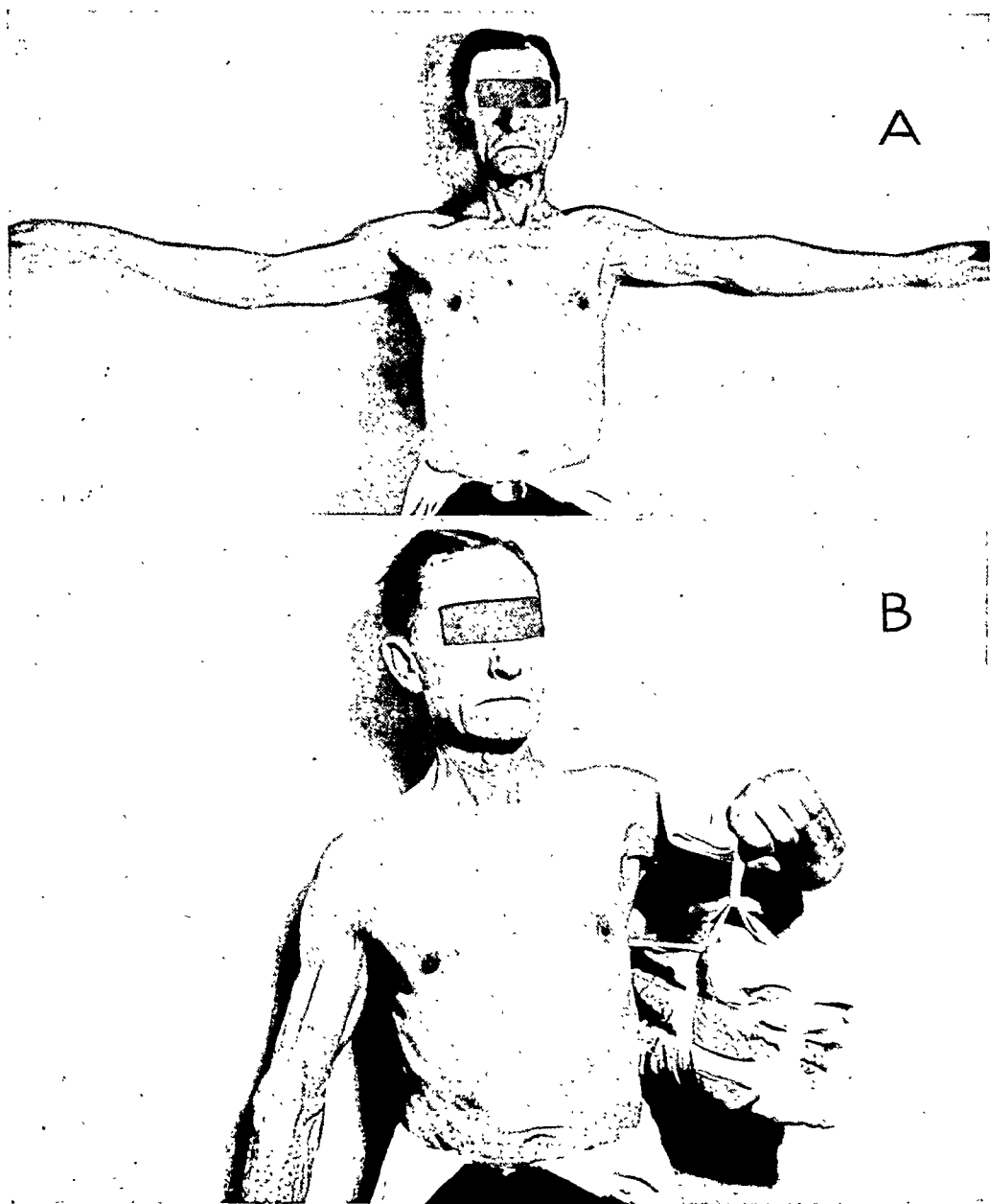


FIG. 6.—A—Showing full abduction possible. B—Showing restoration of function.

points of insertion, and figure-of-eight silk sutures fixed in the ends of each tendon. The head now being resected, the shaft of the humerus is brought through the incision by the operative assistant. The rough surfaces are rounded off with a rongeur, bone-cutting forceps, file, *etc.*, and the fascia lata transplant applied over the end with a purse-string suture. The tendons are

FRACTURE OF HEAD OF HUMERUS

then drawn into the grooves, and the sutures tied to each other. Although it might seem that there would be confusion in the insertion of the tendons, actually there is none as the tendon of the subscapularis naturally falls into the anterior opening, the supraspinatus into the lateral, and those of the infraspinatus and teres minor into the posterior. The tying is performed in such a manner that the upper end of the reshaped shaft fits snugly into the glenoid cavity. The various layers of the wound are closed in the usual manner.

The experience of the present reporter, upon which the following observations are based, is as follows:

CASE I.—July 15, 1926, a carpenter, aged sixty-seven years, fell from a scaffold, striking his left shoulder against a timber. He was immediately taken to the hospital. Because the left shoulder was flattened as compared with the right, his physician made a diagnosis of dislocation. No röntgen examination was made at that time. A Kocher manipulation was performed under anæsthesia. When it was found impossible to reduce the deformity, a röntgen examination was made which showed that the patient had a fracture of the surgical neck, with a subglenoid dislocation of the head. Both the head



FIG. 7.—(Case II.) Pre-operative X-ray.



FIG. 8.—(Case III.) Pre-operative X-ray.

and neck were widely comminuted. This röntgenogram was inadvertently destroyed following the fire scare of several years ago. I was called in consultation the following day, and July 17, 1926, the operation presently to be described was performed.

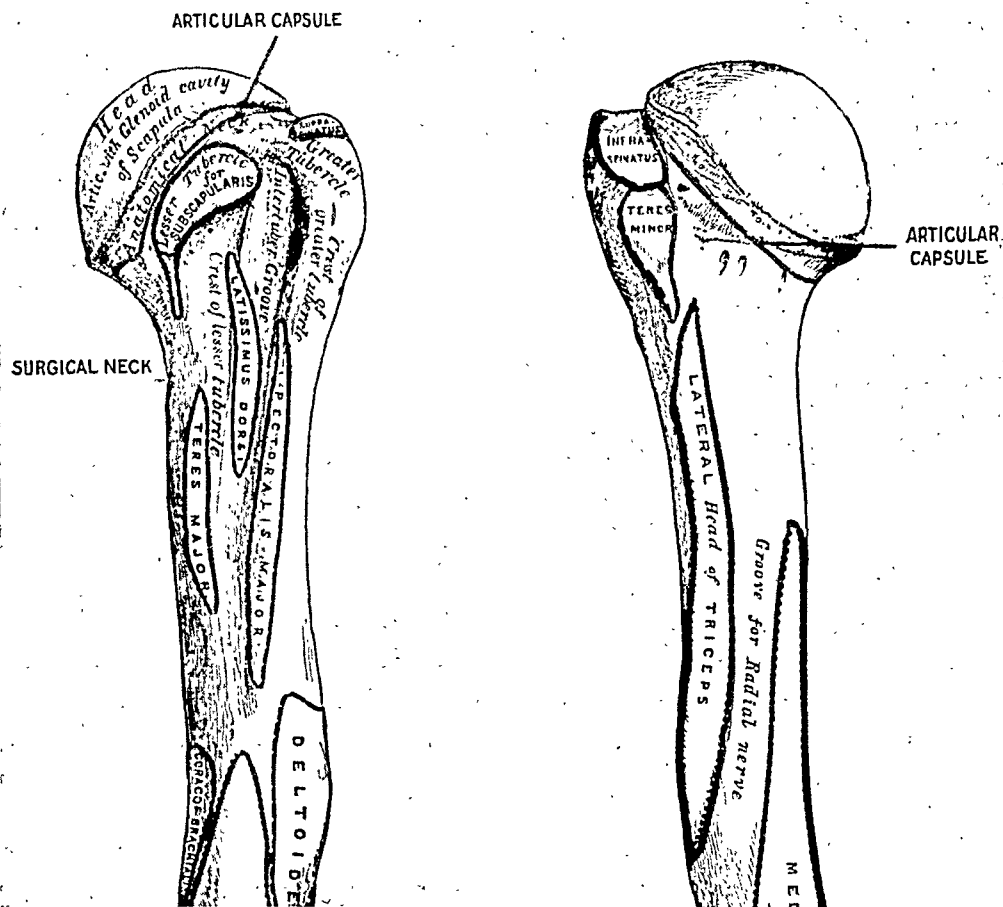
It was necessary on two occasions, two months and five months later, respectively, to manipulate the arm under anæsthesia to free peri-articular adhesions. At the end of six months he was able to return to his work as a carpenter. At the present time, although seventy-two years of age, he is working every day as a janitor at the City Hall, washing windows, sweeping, *etc.* The injured shoulder is as stable as the uninjured. He can carry twenty-five pounds of sandbags with the arm in full abduction.

CASE II.—October 16, 1930, the patient, a mechanic for the City Water Department, fell a distance of about ten feet, from a ladder. He believes he fell directly on the point of the left shoulder. He was fifty-eight years old, not particularly robust, in considerable pain and slightly shocked. The curve of the left shoulder was flattened as compared with the right, and he was unable to move the arm at the shoulder-joint. A röntgenogram demonstrated a comminuted fracture of the upper end of the left humerus at the junction of the head and neck. The greater tuberosity was also comminuted. The upper end of the lower fragment (the shaft) was displaced into the axillary space. Under gas-oxygen anæsthesia, abduction was attempted. A plaster bandage was applied to the

chest, in which was incorporated a metal device for extension of the arm in partial abduction.

The laboratory reported a strongly positive Wassermann, and the following blood count: Hæmoglobin, 70 per cent.; red blood-cells, 3,530,000; white blood-cells, 16,000. He was placed immediately on iodides, and bi-weekly intramuscular injections of one cubic centimetre of bismuth subsalicylate.

Other attempts at reduction, both by manipulation, increasing traction, and changes in splint position, were ineffectual. His general condition had improved, and he had received enough therapy to control his lues, so November 14, 1930, operation was per-



FIGS. 9 AND 10.—Illustrating points of insertion of "short rotators." (After Gray.)

formed. The post-operative course was somewhat stormy. His secondary anaemia became grave, finally resulting, November 25, in a hæmoglobin of 50 per cent., a red blood-cell count of 2,790,000. An indirect citrated blood transfusion of 500 cubic centimetres was given, and the same anti-lytic therapy previously mentioned was resumed. His condition rapidly improved, and he was discharged from the hospital January 6, 1931.

At the present time, he can abduct the arm to an angle of 50° , and carry a sandbag weight of 10 pounds at that angle. Rotation is limited to one-half the normal range of motion. He has returned to work.

CASE III.—February 20, 1932, a housewife, aged sixty-one, fell striking her shoulder directly on the pavement. Following the accident, she was unable to use the arm. A röntgenogram showed a complete transverse fracture at the anatomical neck of the humerus, with the head lying anteriorly and below the sub-coracoid process. There

FRACTURE OF HEAD OF HUMERUS

was comminution of the upper fragment. The patient was considerably overweight and her physical condition did not admit operation until March 5th, when the above procedure was performed.

Four months after operation, the patient can abduct to fifty degrees, has two-thirds the normal rotatory range and can carry a ten pound sand-bag with the arm abducted forty degrees.



FIG. 11.—Case I. Post-operative X-ray.



FIG. 12.—Case II. Post-operative X-ray.

DISCUSSION.—If the results of this operation are considered as experiments in muscle physiology, they prove one point to my entire satisfaction. Up to this point, these transplanted muscles have been referred to as the short rotators as that is their accepted name. I do not believe that is their major function. Rather are they suspensory muscles, whose chief action it is, with the arm abducted, to hold the head of the humerus firmly against



FIG. 13.—(Case III.) Post-operative X-ray.

the glenoid, where the more powerful flexors and extensors, such as the pectoralis major, latissimus dorsi, etc., can exert their full force on a firm base. The usual anatomical plates and descriptions give us an erroneous impression.

In some no mention whatsoever is made of the relationship of the tendons to the capsule. In others, the description of the insertion is accompanied by

such phrases as "fibers are intimately adherent to the capsule" or are "reflected to the capsule." In Cunningham, Morris and Piersol, they are described as if they had a double insertion. For example, "The subscapularis inserts (1) into the small tuberosity of the humerus (2) the front of the



FIG. 14.—Case I. Post-operative X-ray. Arm in abduction.

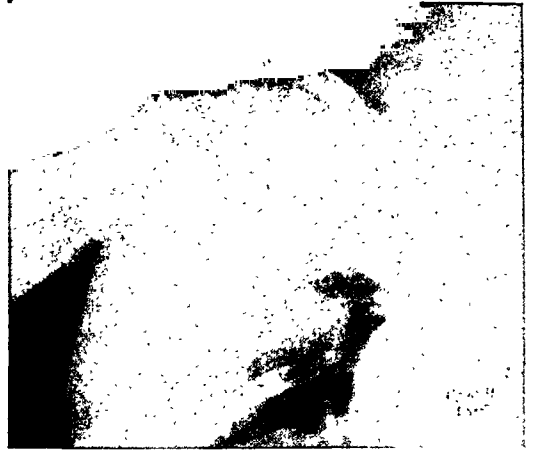


FIG. 15.—Case II. Post-operative X-ray. Arm in abduction.

capsule of the shoulder-joint." Actually, the tendons of these four muscles are inserted into the capsule about one-half inch from the final bony insertion and fusing with the capsule, are then inserted into the semicircle extending from the anterior edge of the lesser tuberosity to the posterior edge of the



FIG. 16.—(Case III.) Post-operative X-ray in abduction.

greater tuberosity. They cannot be dissected free from the capsule and are a part of it.

Doctor Codman once expressed this aptly by saying "The muscles of the shoulder-joint are the capsule." Against the fact that rotation is a major component of their action is first, their insertion into the extreme end of the humerus and secondly, the diffuse manner by which they insert into the capsule. An argument for their basic suspensory action is the fact that,

with all the other muscles removed, when these muscles are cut, the head of the humerus drops away from the glenoid.

Further support to this view is given by a study of the post-operative röntgenograms in these cases. Never was the apparently paradoxical axiom frequently quoted by Dr. Robert W. Lovett better illustrated. The statement was "The bones are held together by muscles, not by ligaments." In support of this assertion, this example was frequently given. A child, following poliomyelitis, has, as an end-result, paralysis of the gluteal muscles. The ligaments of the hip-joint, deprived of the secondary support derived from the enveloping musculature, gradually elongate. Six months to a year later spontaneous dislocation occurs. In all the reported cases here, the shaft is seen lying at the lower margin of the glenoid cavity with a large space between its upper end and the acromion processes, in apparently imminent danger of dislocation into the axilla should the arm be abducted. But so surely do the transplanted muscles function that tests made on the operated side demonstrate no more play than in the normal unoperated shoulder-joint.

Further, X-rays taken with the arm in abduction show that the head of the humerus is pulled securely into the glenoid and that there is no separation in this position. It is also interesting to note how nature, under the stress and strain of functional use, builds up on the inner and upper surface of the bone, a structure which closely approximates a new head.

In all these cases, no attempt was made to plicate the joint capsule. It is then permissible to speculate that, if extreme stability can be obtained under such adverse conditions, then instability may be due to the same factors acting conversely. In other words, lengthening of these muscles may be the cause of secondary relaxation of the joint capsule. An attempt will be made to decide this point by a study of the relationship of muscles to capsule in the presence of habitual dislocation of the shoulder-joint.

BIBLIOGRAPHY

- ¹ Santee, H. E.: Fractures about the Upper End of the Humerus. *ANNALS OF SURGERY*, vol. lxxx, pp. 103-104, 1924.
- ² De Courcy Wheeler, Sir W. I.: Reconstruction of the Shoulder, *Brit. Jour. Surg.*, vol. ix, pp. 247-252, 1921-1922.
- ³ Albee, F. H.: Restoration of Shoulder Function in Cases of Loss of Head and Upper Portion of Humerus. *Surg., Gynec., and Obst.*, vol. xxxii, pp. 1-19, 1921.
- ⁴ Murphy, J. B.: Fracture and Luxation of the Neck of the Humerus. *Surg. Clin., Chicago*, vol. xi, pp. 137-148, 1913.

ELEPHANTIASIS NOSTRA*

BY GEORGE P. MULLER, M.D., AND CLAUS G. JORDAN, M.D.
OF PHILADELPHIA, PA.

FROM THE SURGICAL DIVISION OF THE UNIVERSITY HOSPITAL

ELEPHANTIASIS, called Herculasian disease by the ancient Greeks, has always been a very spectacular affection. Up until the Middle Ages, as Virchow¹ tells us, it was often confused with leprosy due to its similarity in certain phases with the tissue hypertrophy of lepra. Just as the man with elephantiasis was banished from society by certain ancient people who thought him to be a leper, so did certain African tribes make saints out of the victims of this disease because they thought it a special favor of the gods to have a much enlarged scrotum or leg. Even today in more civilized countries we often see an elephant man exhibited in a circus or side show. Sir Frederick Treves² has written a vivid and sad story of an elephant man.

Up to the beginning of this century elephantiasis was a medical curiosity and the only rôle the surgeon played was to undertake the last step of amputating the affected part when it threatened to become larger than its owner. With the rapid rise of surgery this disease has received its share of attention and many different operations have been devised.

For the proper understanding of the treatment one must know first the nature and cause of this disease. As we will see subsequently there is only one elephantiasis but there are innumerable causes for it. Elephantiasis is a chronic inflammatory fibromatosis of the dermal and hypodermal tissues, either preceded or accompanied by venous and lymphatic stasis. Mere venous and lymphatic stasis will not produce true elephantiasis; there must be a second element which is the infection. In the past twenty years there has been much controversy as to the rôle lymphatic obstruction and infection play as etiological factors. Matas³ believes both are of equal importance. Unna⁴ and Saboroud⁵ believe that infection alone by the streptococcus can produce elephantiasis. Kuntzen,⁶ who writes from Payre's clinic, believes that lymphatic obstruction plays the major rôle, the erysipeloid streptococcal infection being secondary and acting only to intensify the course of the disease.

According to the numerous causes we could classify this disease into many varieties. In order to avoid confusion, however, we can distinguish between the elephantiasis which is caused by the filaria and that which is not. In the true filarial elephantiasis the lymph channels are obstructed by the parasites, thus producing fertile soil for the invasion of the streptococcus. It is now generally recognized that the tropical elephantiasis is frequently not

* Read before the Philadelphia Academy of Surgery, April 4, 1932.

ELEPHANTIASIS NOSTRA

caused by filaria. The reason for the greater frequency of elephantiasis in the tropics is the greater exposure of the skin to infection.

In northern latitudes the disease is most often called elephantiasis nostra, distinguishing it from the tropical variety, but there are authorities who give the by-name of nostra only to those cases in which no apparent cause can be detected. Any factor, such as an injury involving the circumference of a limb at its root, or tumors, be their origin carcinoma, tuberculosis or syphilis, involving or pressing on the lymphatics, may ultimately cause elephantiasis, by causing lymphatic stasis. Very often a phlebitis or an inguinal bubo or the cicatricial contraction after herniorrhaphy will with a superadded streptococcal infection produce the disease. In certain cases as for example Milroy's disease, heredity must also be considered an important factor in the etiology. Then we have the true surgical elephantiasis which follows radical breast amputations, and which Halstead⁷ believes is due to infection of the flaps at the time of operation, but which many others believe is nothing but a sign of the recurrence of the malignancy. Kuntzen, who has studied forty-seven cases of the non-tropical variety, includes under the heading of genuine elephantiasis nostra only those cases which begin insidiously in young people at the age of puberty and in which the disease always involves the lower extremity or the external genitalia. It is his belief that because it begins at puberty or occasionally near pregnancy that there is some endocrine factor involved in its production. Kuntzen further emphasizes the localizing element in these cases. As the lymph flows by muscular and valve action the hydrostatic element in the production of this disease is very evident. It is seldom that we find elephantiasis nostra in other than the dependent parts of the body, such as leg, scrotum, or penis. Concerning the rôle of infection, Kuntzen, after careful study of his forty-seven cases, found that in only one case did the typical erysipeloid attack precede the lymphoedematous swelling. He believes that the erysipeloid infection has nothing to do with the cause of elephantiasis but that it is of grave importance for the subsequent course of the disease. It is our belief that without the erysipeloid attacks there may be lymphoedema but there cannot be that true fibromatosis so characteristic of elephantiasis.

A very interesting study of sixty cases of elephantiasis has been made in Porto Rico by Suarez.⁸ He took cultures from what he believed to be the infectious foci of ten cases and got nine positive cultures of hemolytic streptococcus and hemolytic staphylococcus. On the other hand, he took fifty cultures from the tissues of the affected limbs and got only one positive culture.

The typical course of elephantiasis might be described as follows: Recurrent attacks of elephantoid fever, with chills, a temperature around 103°, general malaise, a painful red swollen limb, with enlarged regional lymph-nodes, the entire picture very closely resembling erysipelas. In fact, one of our cases was first treated as erysipelas. After from two to eight days the fever subsides and the patient feels well but the swelling of the part does

not disappear entirely. After about a year or a few months seldom oftener than every month the attack will recur and the swelling subsides less each time. The dermal and hypodermal tissues will hypertrophy and the underlying soft tissues will unite with the skin to form one brawny hard induration and the typical elephantoid proportions will develop. The whole process extends over a period of years and once the erysipeloid habit is developed it will not stop until the elephantiasis is fully developed. There are certain cases where the constitutional symptoms are lacking, but when these patients are carefully questioned they always remember their attacks of redness and swelling. In a fully grown elephantiasis one observes a pillar-like extremity or a scrotum as big as a head. The skin is hard, does not fold or pit, and shows certain trophic disturbances such as nail changes, hyperkeratosis and scaling. Occasionally there will be ulcerations with considerable lymph drainage. The microscopical picture shows a typical hypertrophy of the skin and subcutaneous tissue with an increase in the collagen bundles. The deep fascia is often very much thickened. The vessel walls are hypertrophied and show considerable perivascular round-cell infiltration. The lymph-vessels themselves do not show much change. Interesting and of great importance for the success of the surgical treatment is the fact that the tissue hypertrophy and sclerosis stops with the deep fascia. The disease involves only the structures of the superficial venous and lymphatic system.

The diagnosis of elephantiasis is rather simple. It is easily differentiated from leprosy because the latter is a systemic disease of slow progress and long standing. Recently, Reichert,⁹ of San Francisco, and Golden, in Porto Rico, have taken soft-tissue X-rays and they find a very marked dense trabeculation of the soft parts and in the case of filarial elephantiasis they find the calcified filaria.

The treatment of this disease should be both medical and surgical for each one of them alone does not produce very permanent results. The medical treatment consists of:

- (a) Baking and massage (usually pre- and post-operatively).
- (b) Elevation of limb (usually pre- and post-operatively).
- (c) Compression of limb by elastic bandages.
- (d) Injection streptococcus polyvalent serum.
- (e) Vaccine therapy.
- (f) Fibrolysin.
- (g) Foreign-protein therapy (typhoid, aolin, and whole blood).

There are several cases reported in the literature, especially in more recent times, which have been treated very successfully with vaccine and anti-streptococcus serum alone and it is worth while to employ this treatment in every case possible. A recent case in our own series has shown this. This medical treatment, if it can stop the acute attacks, might be sufficient. In more advanced cases, however, if once the elephantiasis proper has developed, medical treatment is of importance only so far as it helps to prepare

the patient for operation and again post-operatively helps to prevent those very disastrous erysipeloid attacks. The sixteen cases which have been treated by Aubin¹⁰ with streptococcus anti-serum have apparently shown some good immediate results. It is, however, a question as to the permanent results. Preventive treatment is important, namely, to prevent infections of the extremities such as ulcers and phlebitis, also to be careful in the removal of inguinal glands in hernia operations, and not to apply circular bandages in cases where there is danger of venous or lymph stasis.

The earliest reference to any surgical treatment other than amputation was made in 1851, when Carnochan and Morton in this country proposed the ligation of the main artery. This operation, besides risking gangrene, did not produce the desired results. In 1900, Mikulicz and others started to excise large cuneiform pieces of tissue from such limbs and they obtained occasional good results. Finally, Lanz, of Holland, starting with the idea that lymphatic stasis was the underlying evil, proposed a very radical operation for the establishment of new lymph-channels. He made an incision down to the bone, trephined the bone and placed strips of deep fascia into the trephine holes. Lanz obtained excellent results, but his operation was too radical. It is from this operation and from one which Handley proposed in 1908 that the Greek surgeon Kondoleon¹¹ adapted his operation. Handley proposed to establish new lymph drainage by placing silk threads in the subcutaneous tissues, starting at the wrist and extending up into the healthy tissues of the shoulder. The immediate results of his operation were very successful, but later investigations showed that the silk thread was represented by nothing more than fibrous strands and had ceased to give lymphatic drainage.

With Lanz's operation in view, Kondoleon, in 1912, proposed the following operation. Based on the very reasonable theory that in elephantiasis the superficial lymphatic system is diseased and blocked, while the deep lymphatic system is still sound and functioning, he proposed by the removal of the deep aponeurosis covering the muscles to open the way for the formation of new lymph channels between the deep and superficial lymphatic systems. His operation consists of an incision from the trochanter to the external malleolus, down to the deep fascia and the removal of a wide strip of this fascia. The same procedure is repeated on the inner side of the limb. The Kondoleon operation was first performed in this country by Matas in 1912 and he modified it slightly by excising considerable portions of skin and subcutaneous tissue and by sewing the deep fascia against the muscle in order to prevent the reformation of this fascia. Sistrunk¹² at The Mayo Clinic further modified the operation by removing much larger proportions of skin and subcutaneous tissue, thus trying to reestablish the normal proportions of the limb. Payre,¹³ in Germany, who claims to have originated his operation at about the same time as that by Kondoleon, employs an operation similar to that used by Sistrunk. Payre, who has done the same number of operations as Kondoleon, namely, twenty, stresses the pre-operative treat-

ment especially. He advises long-continued bed rest, often as long as four to five weeks, with bandaging and elevation of the limb in order to shrink it as much as possible. The smaller the leg at the time of operation the more tissue can be removed and the better the result. He also lays emphasis upon the fact that as much as possible of the skin should be removed in order to have a sufficient pressure of the skin upon the underlying tissues. Payre, and his co-worker, Kuntzen, take great care in preparing the skin of the affected limb, cleaning it every day and applying sterile bandages for almost a week preceding operation. Sistrunk and Auchincloss,¹⁴ in New York, have independently advocated the correction of the deformity and the removal of as much as possible of the diseased tissues as one of the important features of a modified Kondoleon operation.

The actual technic of the operation consists of an elliptical incision of the skin, removing all excess skin; reflection of skin flap at least six centimetres laterally and then removing a large section of subcutaneous tissue and deep fascia; exposing the muscle and bringing it into direct contact with the skin.

If we now review critically the results of the surgical treatment, we find that the splendid improvement which the originators of this operation had hoped to obtain has not been fulfilled. Kondoleon, who reviewed his twenty cases, in 1924, stated that some of them were improved for as long as two years and then there was a recurrence of attacks. He states, however, that after the operation in spite of the attacks the limb or scrotum always returns to normal size again, and he believes this to be definite proof of the establishment of new lymph-channels by the operation. Summarizing his experience with the operation, he believes there is definite improvement after operation but not a "restitutio ad integrum." Again, Kuntzen, in reviewing twenty-two cases, shows that their immediate results were very good, but that the permanent results are not so encouraging. Out of sixteen cases of the lower extremity, two were completely cured; six were much improved, four very little improved and three were not improved at all. The cases showing the largest improvement were cases of secondary elephantiasis of long standing. The results of the radical operation for elephantiasis of the scrotum and penis have been better. Sistrunk, after ten years of experience, feels that the operation has definite value. Auchincloss, in Porto Rico, has had the same good immediate results, but he also has had many recurrences. The great factor in recurrence is the reappearance of the erysipeloid attack.

CASE REPORTS.—CASE I.—Mrs. M. L., aged fifty-three years, white. First admitted September 12, 1930, to Doctor Muller's service, Misericordia Hospital. Tremendous swelling of right leg. Eighteen years ago, when three months pregnant, the patient noted a generalized swelling of right foot and leg. This swelling would pit on pressure. The swelling persisted during the remainder of the pregnancy but did not become worse. Bed rest after parturition improved the leg, but getting up produced the same swelling. In spite of all palliative treatment, during the last eighteen years, the size of the leg became

ELEPHANTIASIS NOSTRA

gradually worse and in December, 1929, it attained its present proportions. (Fig. 1.) The patient was at that time unable to walk or even to perform her household duties on account of the size of the leg. It began to ulcerate and discharge as much as a quart daily of clear white lymph. The patient has never been farther south than Washington. She states that three months prior to her initial swelling she fell and injured her spine. At the time of her examination by us there was, however, no evidence of injury. Her previous medical history was negative. No elephantiasis in family, apparently only one abortive attack of erysipelas. Mother of four children. Physical examination entirely negative except for her right leg. The lower leg is most markedly elephantoid. The



FIG. 1.—(Case I.) Elephantiasis of right leg. Anterior view. Before operation.

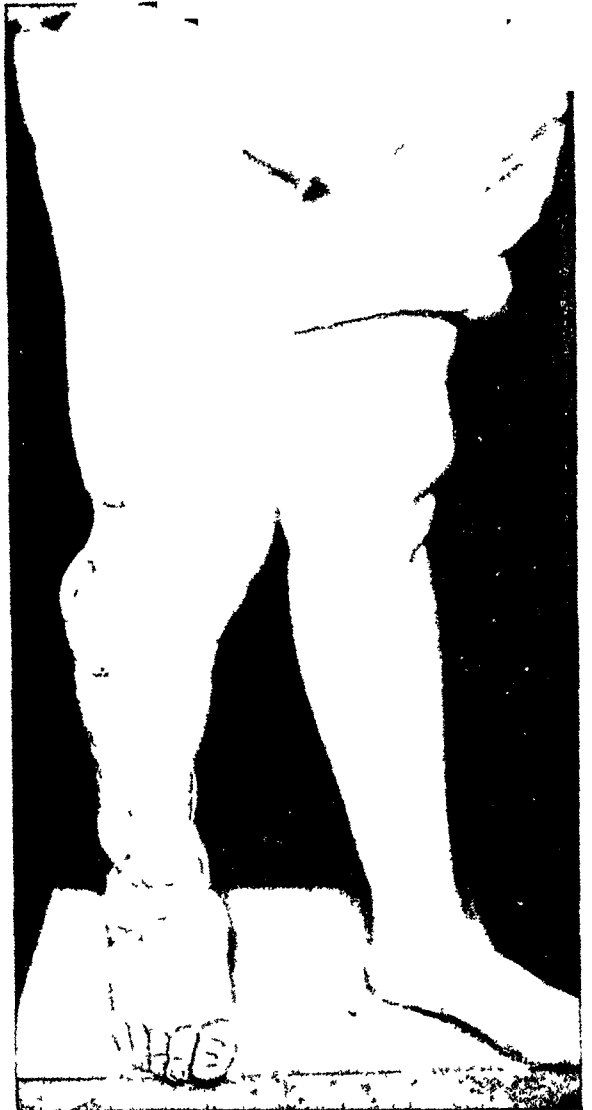


FIG. 2 —(Case I) Elephantiasis of right leg one and a half years after operation.

skin has become very much thickened, it does not pit on pressure, and in the ankle region is covered with numerous wart-like thickenings. The patient was prepared for a week and then the first-stage Kondoleon operation was performed. The skin, subcutaneous tissue, fat, deep fascia were removed from the trochanter to the external malleolus. From trochanter to knee a strip about two and one-half inches was removed and from the knee down the strip varied from two and one-half to five inches. A month later the second-stage Kondoleon on the inner side of the leg was performed. The healing of both scars progressed slowly but steadily and with the help of a small skin graft she was finally discharged eleven weeks after her first admission. The patient was admitted three times during the last one and one-half years for minor plastics on the same leg and at the present time her right leg has almost the same dimensions as her left one. (Fig. 2.)

She is again able to do her housework and can walk. She still has a small granulating area over her external malleolus, but this is healing steadily. For the patient's comfort it is also necessary that she still wears an elastic bandage on her right leg. She has never had any erysipeloid attacks during the last ten years.

CASE II.—W. S., boy, aged thirteen years. First admission, September 27, 1930, Doctor Muller's service, University Hospital. Recurrent painful swelling of both legs. Without previous disease or ill health the boy's legs became painful and swollen about a year before first admission. The condition lasted only for a few weeks in the right leg, but remained for about two months in the left leg. The painful swelling with redness



FIG. 3.—(Case II.) Elephantiasis nostra of left leg before operation.



FIG. 4.—Four months after operation.

and fever returned about every three to four months in the left leg. In the interim, with otherwise good health, the left leg remained, however, somewhat swollen but was not as large as during acute attacks. On September 25, the patient had another attack, which began with chills and fever and was followed about eight hours later by redness and swelling and severe pain. This pain and redness started at the internal malleolus and ascended up the leg as high as the iliac crest. There were no history of trauma and no hereditary factor present. Patient had scarlet fever in June, 1928. Tonsils had been removed several years previous. Physical examination was negative except that the left foot and leg were swollen considerably. The skin of the foot and ankle was thick, dry, coarse and scaling with a tendency to eczema and ulceration. The foot and leg were not tender. A diagnosis of elephantiasis nostra due to repeated attacks of lymphangiitis was made. Pre-operative treatment was started and with the leg elevated the swelling

decreased considerably. The picture shown (Fig. 3) was not taken till two weeks after admission. Kondoleon operation October 16, 1930. The tissues of the lower leg had a decidedly bony feel. The boy's wound healed perfectly and he was discharged November 10. In December, 1930, the patient returned for the second-stage Kondoleon operation. (Fig. 4.) The swelling at this time was much less. Seen in follow-up clinic April, 1931, there was still slight swelling over the external malleolus of left leg. He was going to school, was still wearing an ace bandage. Had not had any attacks since operation. On June 11, 1931, he woke up with a sudden pain in the right foot, followed by a chill and swelling of his right foot this time. The red area spread up the knee in four days. He was admitted with a temperature of 103° and he was treated and diagnosed as erysipelas by the receiving ward intern who did not know his previous history. The left leg at this time was perfect. About the right knee there was an area of redness simulating erysipelas and the entire leg was very much swollen. Ultra-violet light was

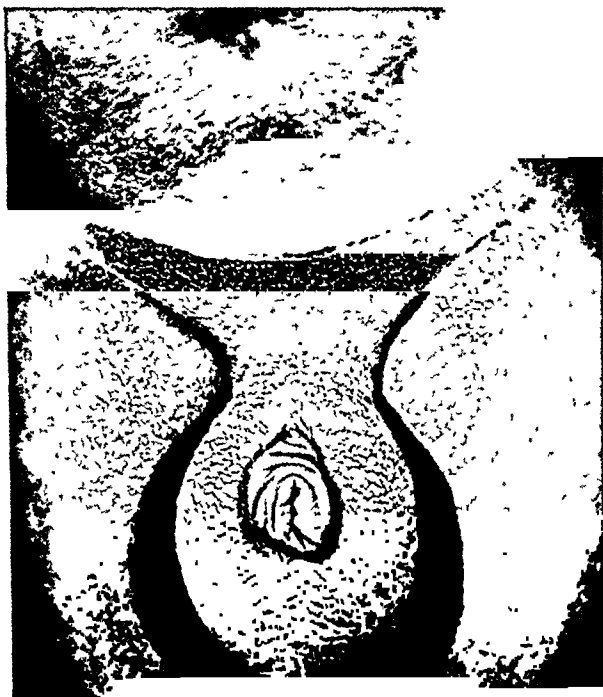


FIG. 5.—(Case III.) Elephantiasis of scrotum before operation.



FIG. 6.—Elephantiasis of scrotum nine months after operation.

applied and arcase dressings. The temperature dropped the next day and the leg became progressively smaller, the redness disappeared, but the inguinal lymph-nodes remained large and tender, and he developed subsequently an abscess in his inguinal region which was incised and drained. A non-hemolytic *Staphylococcus aureus* was recovered and a vaccine was prepared. The patient was discharged again and vaccine treatment was started. His right leg has been free of attacks of swelling since then. He was seen at the follow-up clinic March 10, 1932, and he reported another acute attack of swelling and redness in his left leg, which, however, subsided in twenty-four hours. Both ankles at this time were still somewhat swollen but his legs had never reached the previous elephantoid proportions. He is still wearing an ace bandage, and he is still receiving vaccine treatment. In his case the erysipeloid attacks might prevent a permanently good result.

CASE III.—Man, colored, aged fifty-one years. First admitted May 20, 1931, to Doctor Muller's service, University Hospital. For five years the patient has been treated for lichenplanus in his inguinal and perineal region. During this time there was

a gradual swelling of his scrotum. He also had a strongly positive Wassermann. He was diagnosed as elephantiasis nostra by the dermatology department. Physical examination revealed a scrotum the size of a man's head (Fig. 5) with the penis entirely buried in the scrotum. Operation May 21, 1931, lateral elliptical incisions, removal of almost the entire scrotum. The testicles were replaced in a small pocket of skin. Convalescence normal. Culture showed a none-hemolytic staphylococcus and diphtheroids. Patient was seen in follow-up April, 1932, and his scrotum was small, while the penis was of normal proportions. (Fig. 6.) He had not had any attacks of painful swelling and he was again able to have intercourse, which had been absolutely impossible before operation.

CASE IV.—Male, white, aged forty-eight years. First admitted November, 1930, to Doctor Muller's service, University Hospital. He was sent in as an inguinal hernia. Four years before admission he was operated upon for bilateral inguinal hernia. Three months later the patient noted the swelling in the left side of the scrotum reappearing. Physical examination showed poor teeth and tonsils; there was considerable suprapubic swelling and the scrotum was as large as a cocoanut. The skin over the scrotum is reddened, thick, scaly and boggy; the left side of the scrotum was larger than the right side. The penis is very swollen. Because of recent flare-up of redness and swelling, the operation was postponed. The diagnosis was elephantiasis nostra, probably following his bilateral hernia operation. The patient gave a definite history of fever and vomiting associated with the scrotal swelling. February 19, 1931, operation was performed, consisting of excision of scrotum, bilateral bottle operation for hydrocele and a plastic on the penis. The hydrocele operation was not performed for hydrocele but to prevent the later formation of hydrocele. Lateral incisions were made from the antero-lateral portion of the scrotum down to the postero-lateral portion, the direction of the incision being governed by the extent of diseased tissues. Lateral flaps of normal skin were then secured and the entire scrotum was excised; the testicles themselves were freed and completely isolated; the tunica vaginalis of each testis was opened and inverted to prevent formation of a traumatic hydrocele. A diamond-shaped piece of skin and subcutaneous tissue was then removed from the posterior part of the penis. The lateral flaps of normal skin were then shaped into the new scrotum. The recovery from operation was uneventful. A culture from the scrotum showed hemolytic staphylococcus albus of auranticus type and a none-hemolytic *Streptococcus ignavus*. These are both rare organisms, and are of great interest. The pathological section showed marked oedema of the scrotum and penile tissues with localized areas of round-cell infiltration. The patient was seen in follow-up clinic March 10, 1932. His scrotum is much smaller. He still has occasional attacks of fever, chills, swelling and redness of the scrotum, but the swelling always returns to its normal size very soon and the attacks are much shorter.

CASE V.—Male, white, aged forty-seven years. Admitted November 3, 1931, to Doctor Muller's service, University Hospital, with a fracture of the right femur, lacerations of the forehead, right knee and left ankle, after being struck by a truck. He also had a possible skull fracture and an intra-abdominal or retroperitoneal hæmorrhage. He was put into the Russel traction apparatus and after a fair reduction of his fracture no further attempts were made on account of his serious condition. During the first two weeks he was very sick and several times it seemed necessary to open his abdomen. He was in apparent good health again one month after the accident, but at this time X-ray revealed non-union of his fracture. Open reduction with plating was undertaken December 8, 1931, and a body plaster case was applied. Immediately after the open reduction there was only a slight flare-up of temperature and some abdominal distension. On December 18, 1931, he developed a fever of 104°, his left leg, the right leg was fractured, became red and swollen, he was very sick with chills and vomiting. The entire case was removed and the patient was placed in the Russell's apparatus again. There was a temporary improvement following the removal of his case and then his temperature began to mount again and his leucocytes rose to 26,000. On December 27, 1931, there began

œdema and redness of right leg at the ankle and slowly involving the entire leg up to the iliac crest. One area over the right thigh appeared almost fluctuant and was incised but only clear white lymph was obtained. X-rays at this time showed possible osteomyelitis; this, however, was proved to be wrong in subsequent films. There were several areas of redness, erysipelas-like, with very brawny induration developing around both his ankles, over his right thigh and just below the left iliac crest. During early January, or two months after the accident, there was also the development of scrotal œdema. The entire picture appeared at this time as of an acute attack of elephantiasis nostra of both legs and scrotum. Both legs and the scrotum became tremendously enlarged. On January 10, 1932, active treatment for acute elephantiasis nostra was started. He received repeated small blood transfusions and repeated injections of twenty-five cubic centimetres of polyvalent anti-streptococcus serum. Ultra-violet therapy was also started and viosterol by mouth. After six injections of anti-streptococcus serum, the œdema of his legs began to subside gradually. During the last two months he has improved steadily but slowly. His fracture seems well united and he is out of bed; of course he is not yet able to walk. There remains only one area of brawny induration over the lower right femur. He has not had any more attacks of fever and swelling. The sinus over the right thigh has stopped draining large quantities of lymph. Cultures taken from tissue did not show growth, but cultures taken from the sinus in his leg showed a hemolytic *Staphylococcus albus* and *Bacillus pyocyaneus*. Of course, the great question in this case, as it is in all other cases of elephantiasis, is, will the patient continue to have erysipeloid attacks; and if the attacks will recur he surely will develop true elephantiasis.

BIBLIOGRAPHY

- ¹ Virchow: Volume on Tumors.
- ² Treves, Sir Frederick: The Elephant Man.
- ³ Matas, Rudolph: Surgical Treatment of Elephantiasis. Amer. Jour. Tropical Diseases, vol. i, p. 60, July, 1913.
- ⁴ Unna: Matas article; also see Joseph Elliot. Jour. Cutan. Dis., vol. xxxv, p. 17, 1917.
- ⁵ Saboroud: Matas article.
- ⁶ Kuntzen, Heinrich: The Surgical Treatment of Elephantiasis. Chirurg., vol. ii, p. 667, July, 1930; Surgery of Elephantiasis. Archives f. Klin. Chirurgie, vol. clviii, p. 54, 1930.
- ⁷ Halstead: Surgical Elephantiasis. Johns Hopkins Hospital Bulletin, vol. xxxii, p. 309, 1921.
- ⁸ Suarez: The Rôle of Bacteria in Acute Filarial Lymphangitis. Porto Rico Journal of Public Health and Tropical Medicine, vol. vi, p. 425.
- ⁹ Reichert: The Recognition of Elephantiasis and Elephantoid Conditions by Soft-tissue Röntgenograms. Arch. Surg., vol. xx, p. 543, 1930.
- ¹⁰ Aubin, and Nadessin: Treatment of Lymphangitis and Elephantiasis with Injections of Polyvalent Antistreptococcus Serum. Revue de Medecine et d'Hygiene Tropical, vol. xxiii, p. 91, 1931.
- ¹¹ Kondoleon: The Operative Treatment of Elephantiasis. Zentralblatt f. Chirurgie, 1912; Münchener Med. Wochenschrift, vol. 1, 1912; Archives Franco Belgrs. de Chirurgie, Brussels, vol. xxvii, p. 104.
- ¹² Sistrunk: Elephantiasis. Treated by Kondoleon Operation. Surg., Gynec., and Obst., vol. xxvi, p. 388, 1918; Kondoleon Operation for Elephantiasis. ANNALS OF SURGERY, vol. lxxxv, p. 185, 1927.
- ¹³ Payre: See Kuntzen's papers.
- ¹⁴ Auchincloss: A Modified Kondoleon Operation for Elephantiasis. Porto Rico Journal of Public Health and Tropical Medicine, vol. vi, p. 149.
- ¹⁵ Wirz, F.: About Early Cases of Elephantiasis Nostra. Dermatologische Wochenschrift, vol. xc, p. 336, 1930.
- ¹⁶ Schoffield, Edward: Non-filarial Elephantiasis. British Med. Jour., vol. i, p. 795, 1931.

- ¹⁷ Harris, D. T.: Non-filarial Elephantiasis. *British Med. Jour.*, vol. ii, p. 1079, December, 1930.
- ¹⁸ McGalrch, Leo: Non-specific Protein Therapy in Elephantiasis. *British Med. Jour.*, vol. ii, p. 957, 1930.
- ¹⁹ Tachassoh, Kuttner: Elephantiasis of Penis and Scrotum in Relation to Lymphogranulomatosis Inguinalis. *Beitrage zur Klinischen Chirurgie*, vol. clii, p. 325, 1931.
- ²⁰ Molius, Rodriguez, and del Toro, Jose: Report on Twelve Cases of Auchincloss' Operation for Filarial Elephantiasis. *The Porto Rico Journal of Public Health and Tropical Medicine*, vol. vii, p. 3, September, 1931.
- ²¹ Torgerson, William: Preliminary Report on the Auchincloss Operation for Elephantiasis. *The Porto Rico Journal of Public Health and Tropical Medicine*, vol. vi, p. 411, 1931.
- ²² Stenzel, Kurt: Contribution to the Elephantiasis of the Male Genitalia. *Dermatologische Wochenschrift*, vol. xciii, September, 1931.
- ²³ Schmidt, Alexander: Conservative Treatment of Elephantiasis. *Die Med. Welt*, vol. v, p. 1213, August, 1931.
- ²⁴ Atoppin, J.: Pseudo-elephantiasis of Scrotum. *United States Naval Bull.*, vol. xxix, p. 671, 1931.
- ²⁵ Ward, John: Operative Treatment of Elephantiasis of the Scrotum. *Congres international de Med. Tropical et Hygiene. Comptes Rendue*, vol. iii, p. 399, 1928.
- ²⁶ Suarez: A Preliminary Report on the Clinical and Bacteriological Findings in Sixty Cases of Elephantiasis in Porto Rico. *American Journal of Tropical Medicine*, vol. x, p. 183, 1930.
- ²⁷ Cooke, W. E.: A Case of Early Tropical Elephantiasis Treated by Protein Shock. *Lancet*, p. 390, February, 1928.
- ²⁸ Kondoleon, E.: Late Results After the Surgical Treatment of Chronic Lymphangitis Oedema. *Arch. Provincial de Chirurgie*, vol. xxvii, p. 104, 1924.
- ²⁹ Hill, L. L.: Elephantiasis. *Surg., Gynec., and Obst.*, vol. xxi, p. 334, 1915.
- ³⁰ Royster: Elephantiasis and the Kondoleon Operation. *Jour. Am. Med. Assn.*, vol. lxii, p. 1720.
- ³¹ Winthrop: A Case of Sporadic Elephantiasis. *Jour. Am. Med. Assn.*, vol. lvii, p. 1592.
- ³² Elliot, Joseph: Elephantiasis Nostras, Review of Subject with Report of Case. *Jour. Cutan. Dis.*, vol. xxxv, p. 17, 1917.
- ³³ Burke: Results in Porto Rico After the Kondoleon Operation. *Surg., Gynec., and Obst.*, vol. xlvii, p. 843.
- ³⁴ Horowitz: Duhring's Disease with Elephantiasis. *Revue Francaise de Derm. et Venereal*, vol. vi, p. 524, 1930.
- ³⁵ Henry: Kondoleon Operation in Elephantiasis. *British Jour. Surg.*, vol. ix, p. 111.
- ³⁶ Strasser, J.: A Remarkable Case of Elephantiasis Nostras. *Med. Klinik*, p. 727, 1915.
- ³⁷ Shattuck: Elephantiasis. *Boston Med. and Surg. Jour.*, p. 107, 1910.

INTRACAPSULAR FRACTURES OF THE NECK OF THE FEMUR

A CLOSED DOUBLE-SCREW METHOD FOR REDUCTION AND FIXATION— PRELIMINARY REPORT

By LAURENCE JONES, M.D.

OF KANSAS CITY, MO.

IN REPORTING any method of treatment, the surgeons to whom it is presented, accept or reject it in accordance with the counseling of their past experience. The method about to be reported has but lately emerged from the rigorous tests of the anatomical laboratory. Because it has excited such lively and complimentary interest among men interested in the treatment of fractures, I take the liberty of making a preliminary report.



FIG. 1.—Model illustrating both the guide wires and double-screw.

Briefly, the procedure is that, under röntgenographical control, the neck and fractured head are placed in line through the use of the Whitman position. The fragments are fixed by two Kirschner wires which also act as directional guides. At this point, the simile is apt that the head is strung on the wires like a bead. A double screw of special design is inserted.

It does not fall within the scope of this paper to discuss the results in

the treatment of intracapsular fractures of the neck of the femur. That has been done recently in an excellent article by Gill.¹ His conclusions are notable for their frankness, and will convince anyone that there is great room for improvement.

The excellence of the results recently reported by Smith-Petersen²

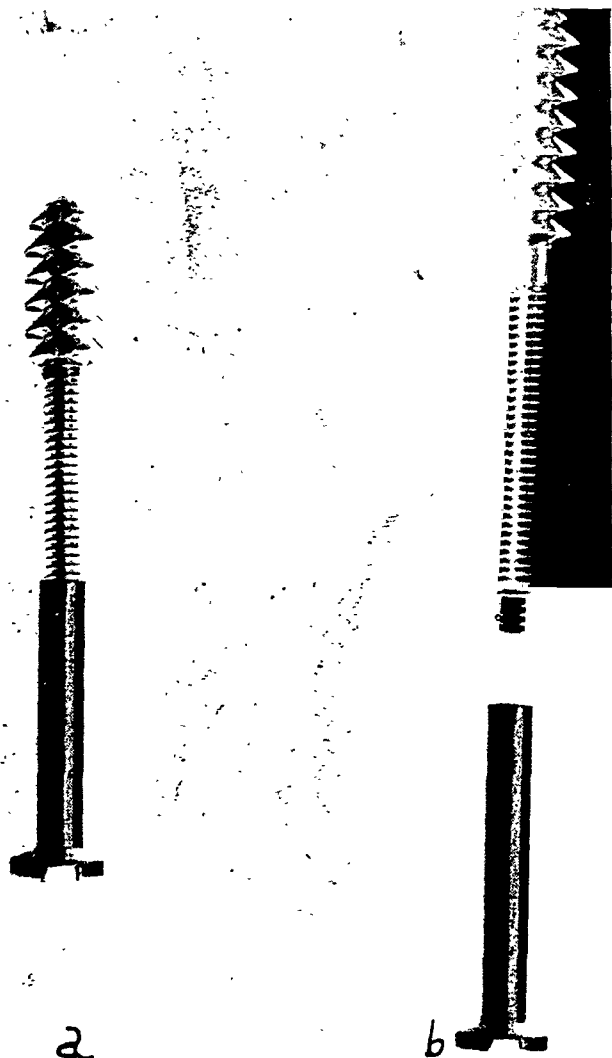


FIG. 2.



FIG. 3.

FIG. 2.—(a) Double-screw assembled. (b) (Above) Double-screw detached, showing in proximal portion, burr, shaft with square end for socket wrench. (b) (Below) The traction-cap and groove for screw-driver.

FIG. 3.—End-view of burr and traction-cap showing control hole.

through the use of the three-flanged nail has revived interest in the use of mechanical internal fixation in such fractures.

Experience with the method will determine whether such fixation will be used in fresh fractures, or when non-union has occurred. In my opinion, its field will be greatly broadened to include the numerous doubtful surgical risks having this type of fracture, if fixation can be performed without open-

INTRACAPSULAR FRACTURES NECK OF FEMUR

ing the hip-joint. This work was undertaken somewhat less than a year ago to determine if such a method could be devised.

At the outset it was determined that the mechanical device used for fixation of the fragments must meet certain requirements. These were, first, ease and accuracy of introduction; second, secure fixation; third, small size; fourth, adjustable length to meet variations in femora; fifth, ease in removal. We believe we have met these in the appliance about to be described.

An entirely new type of screw was designed. Rustless iron* was the



FIG. 4.—Armamentarium showing: (1) Drill with adjustable stop on shaft. (2) Socket-wrench for squared end of proximal part of screw. Adjustable stop on shaft. (3) Screw-driver showing projecting tip for central hole of traction-cap. (4) Extractor to be used in case of false passage. (5) Impactor. (6) Hammer.

material chosen. It can be accurately machined, highly polished, and it has been shown by Zierold³ and Henry⁴ to be less irritating in bone than other

* Free machining Stainless Iron No. 2—

| | Per cent. | | Per cent. |
|-----------|-------------|------------|-------------|
| Carbon | .10 maximum | Phosphorus | .03 maximum |
| Manganese | .30-60 | Sulphur | .30-45 |
| Silicon | .30-50 | Molybdenum | .55 approx. |
| | Chromium | | 14.00-15.50 |

Reported by Research Laboratory Crucible Steel Company of America.

materials. Only the briefest attempt will be made to describe the screw and the instruments used as the illustrations will do this far better.

The screw consists of two parts, a proximal one for the femoral head, and a distal one, or traction-cap for the trochanter. The proximal portion has likewise two parts, a head and a shaft. The head is burr-shaped, is regularly threaded, and has four deep grooves cut at a right angle to the threads. It was found that this type of head cut easily through bone, making its own receiving grooves in the process. The shaft is threaded to fit the receiving shaft of the traction-cap, and the end is squared for the use of a socket wrench.

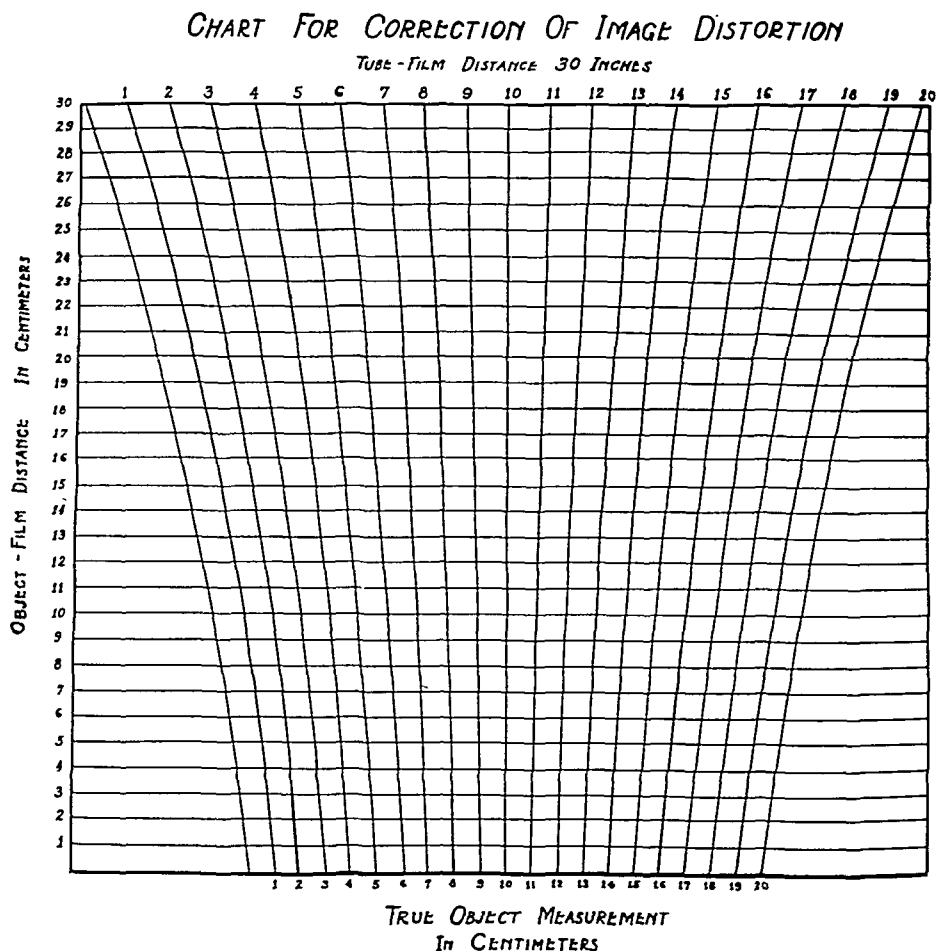


FIG. 5.—This chart actually measures 31 centimetres along the ordinate and 33.5 centimetres along the abscissa. (After Henry J. Walton, M.D., *American Jour. of Roent. and Radium Therapy*, vol. xv, No. 6, p. 758, June, 1931.)

The distal portion of the appliance, or traction-cap, has a shaft and a head. The head is rounded and the face grooved for the use of a screw-driver. In the centre of this groove is a hole designed to fit a projecting tip on the screw-driver. This obviates slipping, but in addition has a more important purpose. The double-screw functions by action at two points, one where the fractured femoral head is fixed on the burr, the other at the point where pressure is directed against the cortical bone of the trochanter by the traction-cap. It is obvious that a screw that is too long could be completely closed before the fragments were locked. In screwing on the traction-cap, the pin on the end of the screw-driver will strike the shaft of the proximal portion of the screw before complete closure can be effected. This would give notice to the operator to

INTRACAPSULAR FRACTURES NECK OF FEMUR

substitute a proximal part with a shorter shaft. The proximal portion has been made with shafts of two lengths, one cap fitting both. In the disarticulated and fractured femoral head, and in cadaver experiments, an exceedingly firm union was established.

Armamentarium.—The drill and socket wrench, both with adjustable stops, the screw-driver extractor, impactor, and hammer seem to need no explanation other than the illustration. A Kirschner wire drill and a motor-driven device used for the large drill form a part of the equipment used. The motor is not essential as we have used an ordinary carpenter's wood-drill.

Technic.—In any closed method, measurement and localization must be by means of the röntgenogram. An interesting suggestion was made by Dr. Rex Diveley that the fluoroscope be used. It is quite sound but my personal feeling is that fluoroscopical technic would entail prolonged exposure for the surgeon.

In detail, the actual steps are as follows: A preliminary anteroposterior röntgenogram is made, the tube target centred over the femoral head and neck, and elevated to a point exactly thirty inches from the plate. The distance from the anterior margin of the trochanter to the plate is then measured and recorded in centimetres. The patient is placed in the Whitman position during the exposure. Measures are made on the film to allow Kirschner wires to pass from the trochanter through the neck and head. The desired screw-depth is likewise measured on the film.

The measurements in the case to be reported actually made on the film are as follows (see Fig. 9):

- (a) Superior for upper Kirschner wire = 11.6 centimeters
- (b) Inferior for lower Kirschner wire = 12.8 centimeters
- (c) Middle for double-screw = 9.0 centimeters

These measurements are corrected for magnification by consulting the chart. The object film distance, *i.e.*, the measurement from the trochanteric region to the plate, is thirteen centimetres. The measurements given above are then applied along the line reading thirteen centimetres and the correct figure obtained without intermediate calculation. For example, it will be observed that the measurements for the superior Kirschner wire (a) which is 11.6 centimetres, when laid on the transverse line 13, fell at a point between vertical lines 9 and 10 to give a measurement of 9.7 centimetres. Hence, the measurements to be used, having now been corrected for Röntgen magnification, are as follows: (a) 9.7 centimetres; (b) 10.7 centimetres; (c) 7.5 centimetres.

Pre-operative plaster bandages should be applied from the foot to a point six inches above the knee-joint on both legs. This helps in maintaining position as it eliminates turning at the ankle. Extension straps are placed over these and the patient placed in the Whitman position; *viz.*, legs extended in a position of wide abduction and extreme internal rotation.

The anæsthetic of choice is given, and I believe local anæsthesia will prove quite satisfactory. In the reported case, nitrous oxide-oxygen was used. A

two-inch trochanteric incision is made, using the gluteal ridge as a guide, and starting one inch below this point and one-half inch from the anterior

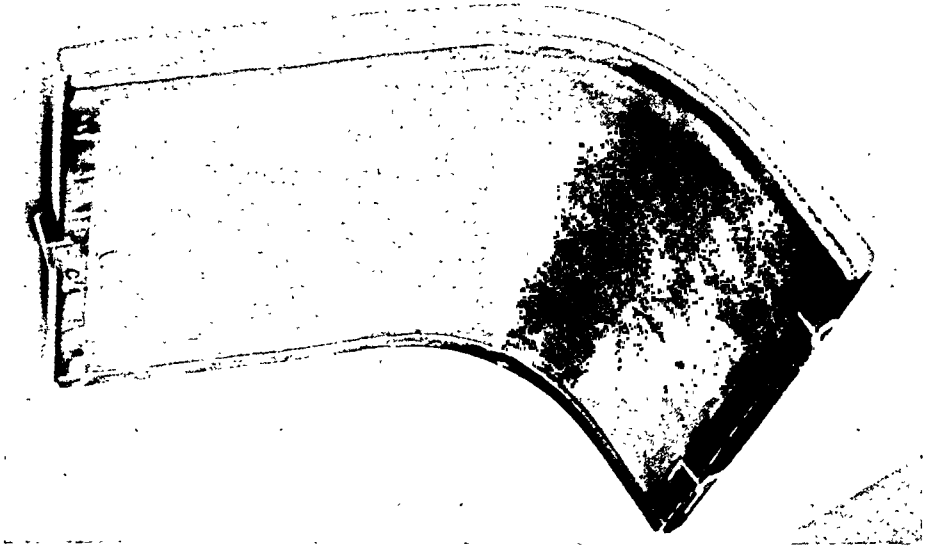


FIG. 6.—Curved cassette for lateral röntgenograms of femoral head and neck.

margin of the femur. The first wire, of a length determined by the measurements, is drilled in direct transverse plane, and one inch below a second wire of correct length is similarly drilled. The part of the wire that was gripped



1-21-31 #204 1000

FIG. 7.—Anteroposterior view immediately following injury.



3-1-32 1.4 1000

FIG. 8.—Anteroposterior view ten weeks after injury.

by the chock of the drill projects from the bone. At this point anteroposterior and lateral röntgenograms are made, and if the wires are satisfactorily placed in both views the next step is ready. If one or both are not so placed, other

INTRACAPSULAR FRACTURES NECK OF FEMUR

wires are used, the first pair giving the proper location for the second, the first then being withdrawn. For the purpose of prompt identification in the

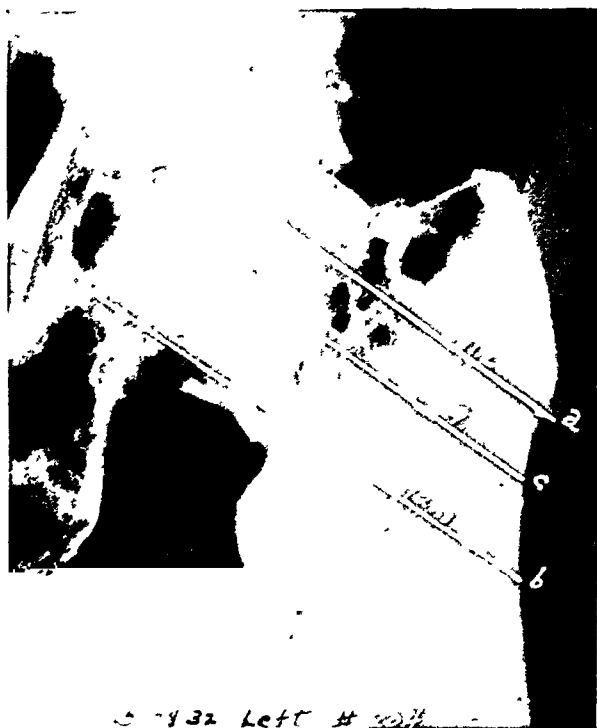


FIG. 9.

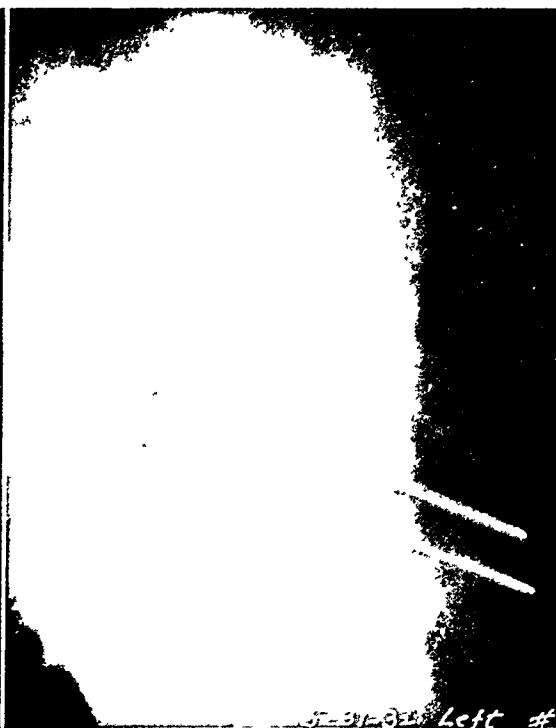


FIG. 10.

FIG. 9.—Anteroposterior view four months after injury showing neck erosion and non-union. Measurements made on this film.

FIG. 10.—Anteroposterior view showing both wires apparently perfectly placed.

lateral view, it might be well to identify one wire with a numeral on the projecting end.

A stumbling block was encountered in the development of a satisfactory



FIG. 11.



FIG. 12.

FIG. 11.—Lateral view showing upper wire in good position, lower wire posterior to neck.

FIG. 12.—Lateral view showing position of double-screw.

technic for the taking of lateral röntgenograms with the patient on the pelvic support of the fracture table. A curved cassette was constructed which could be slipped between the upright bar and the patient's groin. Further



FIG. 14.—Anteroposterior view immediately following removal of double screw.

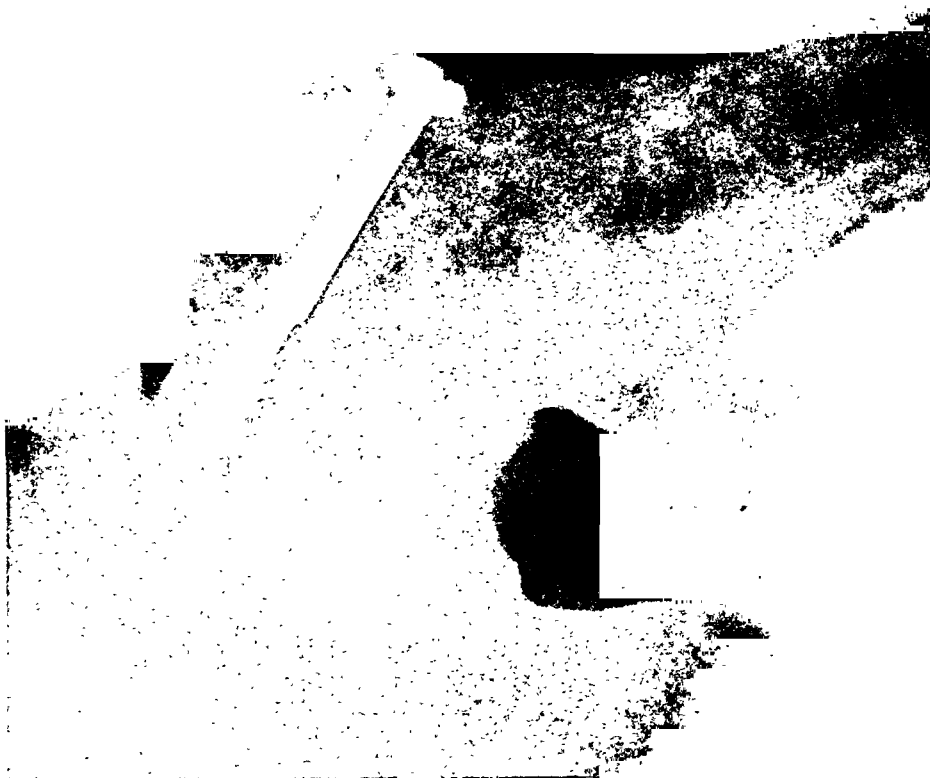


FIG. 13.—Anteroposterior view showing position of double-screw.

INTRACAPSULAR FRACTURES NECK OF FEMUR

difficulty arose in lifting the patient on and off the cassettes. This difficulty, though not serious, is time-consuming. It will be overcome by cassette-holders or frames, which will enable the cassettes to be removed or inserted without moving the patient, once in position.

Once the wires are in the proper position, a stop is placed on the shaft of the drill at the measured distance, and a drill-hole slightly smaller than the screw-head is made. The projecting ends of the wires act as a guide for the drilling direction.

In the cadaver, it was found that the wires eliminated any tendency for rotation of the head, during the subsequent steps. The proximal portion of the screw is then placed in the socket-wrench, and a stop placed on the shaft of the wrench at the previously measured drill depth; *viz.*, pin length plus a measured distance on the shaft of the socket-wrench equals the drill-length. The head is firmly engaged on the burr by simply turning the handle of the wrench. The distal portion of the double-screw or traction-cap is threaded on the shaft of the proximal part and tightened with the screw-driver. When it has been tightened to the limit, the impactor is placed over it and given several sharp blows with the hammer. Several additional turns can usually be made. The guide wires are removed and the skin incision closed.

CASE REPORT—P. M., male, aged sixty-five, January 20, 1932, slipped on an oily floor, fracturing the neck of the femur close to the hip-joint. The typical Whitman treatment was given for ten weeks. The röntgenogram made at that time reported that the fragments were in good position and united by hard callus. He was given a splint designed to prevent weight-bearing, a heel-raise on the opposite side, and crutches. Pain was complained of at intervals, and another röntgenogram taken six weeks later showed marked erosion of the neck of the femur.

Non-union having persisted for almost five months on May 31, 1932, the procedure as previously described was performed. The pre-operative measurements were as given in the example; upper wire 9.7 centimetres, lower wire 10.7 centimetres, screw-measurement 7.5 centimetres. It is worthy of note that in this first clinical attempt the screw was placed directly in the centre of the head in the optimum position. A study of Fig. 13 will show the drill track below the screw. It was found that the burr did not grip in this position, and I believe study of the röntgenogram indicates central necrosis of the head. Another drill-hole was made slightly higher, explaining the final position of the screw. At that point satisfactory fixation and impaction were effected. The necessity for the lateral röntgenogram is shown by a study of Figs. 10 and 11, which show excellent position for both wires in the anteroposterior view, but the lower wire slightly posterior to the neck in the lateral view. The upper wire, however, was in excellent position in both views, and the projecting end gave the proper localization for the subsequent steps.

Convalescence was entirely uneventful. No plaster case was applied but instead a light pelvic brace, partially immobilizing both legs to above the knee-joint, in slight abduction. Baking and massage were started immediately and movements below the knee encouraged.

Röntgenograms were made at monthly intervals. At the end of four months, union was considered satisfactory. Generalized bone atrophy was noted in the segment occupied by the screw. On October 14, 1932, under local anesthesia, it was removed. The burr of the proximal portion was still tightly engaged in the head. Six months after fixation, the range of motion in the affected hip is roughly one-half normal, motion is painless and weight bearing, while still protected, is well tolerated.

Comment.—Necessarily, a preliminary report is the place for strictly limited conclusions. A method has been devised whereby intracapsular fractures of the neck of the femur can be internally and mechanically reduced and fixed using a closed technic. The detailed results of this method of treatment will be made the subject of a subsequent report.

I wish to make grateful recognition of the untiring assistance rendered me by Dr. David S. Dann and Mr. Erich Hanicke. Many of the features of the various appliances are entirely the product of Mr. Hanicke's ingenuity. The röntgenographical technic was similarly developed by Doctor Dann.

BIBLIOGRAPHY

- ¹ Gill, A. Bruce: Fractures of the Neck of the Femur. *ANNALS OF SURGERY*, vol. xcvi, No. 1, p. 1, July, 1932.
- ² Smith-Petersen, M. N., *et al.*: Intracapsular Fractures of the Neck of the Femur. *Arch. Surg.*, vol. xxiii, No. 5, p. 716, November, 1931.
- ³ Zierold, A. A.: Reaction of Bone to Various Metals. *Arch. Surg.*, vol. ix, No. 2, p. 365, September, 1924.
- ⁴ Henry, Myron O.: Proximal Osteosynthesis in Intracapsular Fracture of the Hip. *Jour. Bone and Joint Surg.*, vol. xiii, No. 1, p. 530, July, 1931.

LOCALIZED TUBERCULOSIS OF THE CHEST-WALL *

BY RICHARD H. MEADE, JR., M.D.

OF PHILADELPHIA, PA.

FROM THE DEPARTMENT OF SURGERY AND GYNECOLOGY OF THE UNIVERSITY OF VIRGINIA, AND FROM THE "A" SURGICAL SERVICE OF THE EPISCOPAL HOSPITAL OF PHILADELPHIA

GRAHAM¹ states that "tuberculosis is the most common condition involving the ribs and sternum," and Riedinger and Kümmell² found 104 cases of tuberculosis of the ribs and sternum among 1,795 cases of bone tuberculosis in the Eppendorf Hospitals. Recently there appeared a report from the Maritime Hospital of Berck, France, recording forty-five cases of cold abscess of the chest-wall during a five-year period.³ John Alexander,⁴ with his extensive practice among tuberculous patients, reports that he saw seven cases last year. In striking contrast to these figures are those from the surgical services of two large hospitals in this country. At the Episcopal Hospital in Philadelphia the records of only three proven cases of tuberculosis of the chest-wall could be found for a twenty-one-year period; while at the Hospital of the University of Pennsylvania during the same period no proven cases could be found in the surgical records, although in each institution a number of cases of bone tuberculosis are seen each year. This striking discrepancy in figures can be explained in only one way. Tuberculosis of the chest-wall is usually neither very painful nor dangerous to life, and as most physicians consider its treatment purely palliative at best they do not send their patients to the surgeon. In certain centres the practitioners have learned of the good results of proper surgical therapy and so refer their patients. Here in Philadelphia it seems that such is not the case.

That the subject has not been ignored in recent literature is attested by the excellent article by Heuer⁵ in Nelson's System of Surgery, and the careful reports of Richard,⁶ Ito,⁷ Sorrell,⁸ Kaufmann,^{8, 9} and others.

The term, localized tuberculosis of the chest-wall, is here applied to those lesions in which there is no demonstrable communication with a tuberculous process in the spine, or intrathoracic tissues. Though this would suggest that the local process was a primary one, such is rarely the case for a careful search will usually reveal evidence of tuberculosis elsewhere in the body. The lesion of the thoracic cage is thus only a local manifestation of a systemic disease.

Pathogenesis.—Conflicting theories have been advanced to explain the development of the local lesion. The older and more generally accepted view considers the blood-stream as the distributing medium with a costal periostitis, or osteomyelitis, as the first indication of the localization. Less frequently a soft tissue abscess forms first and rarer still the costal cartilage shows the initial change. Notable among the writers who have emphasized

* Read before the Philadelphia Academy of Surgery, April 4, 1932.

this method of origin are Heuer,⁵ Ricard,¹⁰ and Sorrell.³ The concept of the development of the chest-wall process as the result of lymphatic spread from an intrathoracic focus has been ably supported by the writings of Auchincloss¹¹ and Kaufmann.^{8, 9} They believe that the structures beneath the chest-wall act as the distributing foci. Even though no evidence may be apparent at operation Auchincloss feels that the lungs, pleura and mediastinal lymphatics are "preëminently responsible." Kaufmann,⁸ in a recent article, gives the results of his study of specimens removed at operation. He found that the lymph-nodes of the intercostal spaces were always involved. These were infected, he believes, as the result of a tuberculous pleurisy but did not give rise to an abscess until the pleural lesion had become healed. This assumption would account for the healthy appearance of the pleura so frequently observed at operation on these cases. Depending upon the contiguous structures encountered in the outward spread of the process the apparent lesion would be an osteitis, chondritis, or soft tissue abscess. John Alexander⁴ also believes that most cases spring from infection of the thoracic lymphatics, especially those of the internal mammary chain.

From a study of the literature and from my own experience it would seem that there is abundant evidence that the tuberculous process of the chest-wall may arise either by way of lymphatic extension from an intrathoracic focus, or by way of the blood-stream from a similar area. The concept of a true primary lesion rests on the knowledge that no tissue of the body is immune to invasion by tubercle bacilli. On the other hand, practically all patients with the local manifestation show evidence of concurrently active, or previously active, intrathoracic tuberculosis. This I believe to be true in spite of the reports of Mercadé,¹² Gruget,¹³ and others to the contrary. For in none of their cases was Röntgen examination of the chest recorded. And it is only by such investigation that the intrathoracic tissue can be said to be free from tuberculosis.

For convenience of discussion the process will be considered in regard to the various locations in which it develops. The osseous ribs and sternum are most frequently attacked, the soft parts less frequently, and the costal cartilage least of all. In the report from the Berck Maritime Hospital for the years 1922 to 1927, there were thirty-one cases of tuberculosis of the ribs, ten of the soft parts alone and only four of the costal cartilages, and the reporters consider the cartilaginous origin to be rarer than these figures would indicate.

The Soft Tissues of the Chest-wall.—Although the soft tissues of the chest-wall are less frequently the site of early involvement than the bony cage, they are almost invariably involved by the time that the patient presents himself for treatment, regardless of the site of the origin. The most obvious type of soft tissue abscess arises as a result of aspiration of a tuberculous pleural effusion and is an example of local implantation of organisms. Heuer⁵ has reported a case of multiple tuberculous abscesses occurring in the subcutaneous tissue of a man's chest, and one may see a superficial abscess

TUBERCULOSIS OF THE CHEST-WALL

arising from an axillary, or pectoral lymph-node. The common type, according to Sorrel and Sayag-Dromer,³ arises in the subcutaneous tissue, or in the connective tissue in the muscles. The pleura, the endothoracic fascia, and the lymphatics of the chest-wall, have all been described as sites of origin. Whether or not it starts in the pleura or other deep-seated layer the process always advances outward, either directly, or after a lateral deviation. Practically all writers agree that inward spread is unknown. During the deep stage no symptoms may be present, or there may be a dull constant pain which is accentuated by deep breathing. As the lesion becomes more superficial a slight swelling is noticed which grows so slowly that it causes little alarm. At this time examination reveals a rather firm, rounded protuberance which gives the impression of deep fluctuation. There is usually no acute tenderness but pressure may produce vague discomfort. Later the skin shows the effects of pressure, becoming thin and cyanotic, and a definite encircling zone of induration can be felt. Eventually, in the untreated case the skin is perforated, allowing the escape of fluid which varies in character from a thin, clear, yellow one to a thick, grayish one. The important feature of the fluid is its sterility on routine culture and the positive evidence of tuberculosis elicited by guinea-pig inoculation or growth of the bacilli on special media. Following the perforation a sinus persists for a long time before secondary infection develops and produces the characteristics of an acute pyogenic abscess.

In arriving at a diagnosis of the condition the history of insidious development of the swelling is important, as is the absence of the usual signs of acute inflammation. Evidence of tuberculosis elsewhere in the body is very helpful and röntgenographical study of the chest should not be omitted. Aspiration of the unruptured abscess usually clinches the diagnosis, although rarely histological study of the tissue is necessary. The manner of removal of the fluid is very important. Aseptic technic is essential, and the needle should be introduced through the adjacent normal skin in order to avoid injury to the thin roof of the abscess which would result in sinus formation and secondary infection.

As must be repeatedly emphasized, the abscess is only the local manifestation of a systemic disease and its treatment, therefore, must be undertaken only in conjunction with measures directed at the underlying process. Under very favorable environmental conditions combining heliotherapy with rest, fresh air, and nourishing food, the chest-wall lesion may undergo spontaneous healing. This, unfortunately, is of rare occurrence. It is more practicable to also institute local treatment. In the past this has consisted in keeping the abscess empty by repeated aspiration, or by replacing the contents with iodoform and glycerine. Incision and evacuation of the abscess with primary closure is little better as it does not remove the source of the trouble. Far more rational seems the complete extirpation of the diseased tissues with primary air-tight closure of the wound. When this is done one can definitely exclude the presence of an underlying osseous, or cartilaginous involvement,

or satisfactorily deal with it if present. The results from this method are excellent and the patient is spared a long-standing lesion.

The Ribs and Sternum.—Tuberculosis of the ribs and sternum is more common than that of the cartilage or soft tissue, as has been noted above. In discussing the pathogenesis of the chest-wall lesions it was pointed out that there was considerable evidence to support the theory that the underlying focus was beneath the rigid thoracic cage and that the ribs and sternum were involved in the outward extension of the infection. According to Heuer,⁵ on the other hand, the process in the rib usually starts centrally as if it was hematogenous. He states that there is at first a small focus of tuberculosis in the medulla of the bone. This gradually increases in size, causing destruction of the cancellous bone and a bone abscess results. The periosteum becomes thickened as does the overlying fascia and these together with the cortex are perforated by the expanding process and a soft tissue abscess is produced. Further progress may follow two main lines; one outward and the other laterally. If advance is directly outwards the overlying skin is soon involved and a sinus forms. If the disease progresses laterally the cartilage becomes involved. In some cases many ribs are attacked and the resultant abscess is a large one. In either case the skin is eventually damaged and following the appearance of sinuses secondary infection develops.

An interesting example of the outward spread of the disease was a case reported by V. Aloï,¹⁴ in which the breast of a pregnant woman became the site of a large abscess arising from a tuberculous osteomyelitis of the underlying sixth rib. Less frequently, the process begins as a periostitis. According to Sorrel and Sayag-Dromer,³ after destruction of the periosteum ulceration and erosion of the bone take place with the formation of a cavity containing small sequestra. Pathological fracture may occur but usually there is simply the outward extension of the process with the formation of a soft tissue abscess. Heuer⁵ points out the importance of the site of the initial periosteal involvement. The anterior surface is most frequently involved. When the posterior periosteum is the point of origin the line of advance is usually through the overlying rib. Cases have been observed in which extension occurs between the chest-wall and the costal pleura. The destruction of the posterior periosteum causes necrosis of the rib but sequestra are rarely observed. It is quite generally agreed that inward extension of the process to involve the pleura is never observed.

The ribs most frequently involved, according to Sorrel and Sayag-Dromer,³ are the fourth to the tenth; and of these the lateral and posterior segments are sites of choice.

The sternum is attacked in the same way as the ribs and the changes occurring in it are similar. Not only may the bone itself be the site of the disease but the joints also may become involved. Perforation posteriorly from the sternum is usually prevented by the firm layer of fascia which separates it from the mediastinum, but a few cases have been reported in

TUBERCULOSIS OF THE CHEST-WALL

which this has occurred. Such a complication is of course of grave significance.

In considering the diagnosis of tuberculosis of the ribs and sternum the same points stressed under the heading of soft tissue tuberculosis are to be considered here. In addition, however, the bone changes will be revealed in most instances by the röntgenogram. Indeed, at times a diagnosis of tuberculosis of the rib or of the sternum may be made before the involvement of the overlying soft tissue takes place when the röntgenogram incidentally demonstrates the lesion during the Röntgen study of the lungs of a patient with tuberculosis. In considering the diagnosis of tuberculosis of the sternum one must always carefully consider the possibility of syphilis as gummata of the upper sternocostal region are not infrequently found. The laboratory here proves of great assistance with serological studies.

Treatment.—As has been stated before, general treatment must always be followed and attention is not to be limited to the obvious local lesion. Under exceptionally favorable conditions conservative treatment may suffice in the early stages. In general, however, surgical intervention is necessary. This will consist of excision of the soft tissue abscess and of the underlying involved rib or sternum. It is important to make a wide excision of tissue going well out into the healthy area. It is not usually necessary to remove the entire periosteum with the rib, as in most cases only the overlying portion is involved, and that secondarily. And it is striking how many cases do well after simple subperiosteal resection of the diseased bone, when one considers that according to some writers the bone is only secondarily involved. In those cases in which secondary infection has not developed, even in the presence of sinuses, primary closure of the wound without drainage is the method of choice. Practically all recent writers are firmly in agreement on this point. If it is necessary to use a drain because of uncontrolled oozing, the material should be of non-irritating substance and should be removed after one or two days at the latest. Meticulous hemostasis and the obliteration of large dead spaces by pressure of firm dressings, by suture, or muscle pedicle graft will do much to ensure primary healing.

The Costal Cartilages.—Tuberculosis of the costal cartilage occurs quite frequently as the result of extension of the disease from the corresponding rib, and less frequently from disease of the adjacent lymphatics. About these two forms there is little dispute. On the other hand, the question of primary tuberculous chondritis has brought forth much discussion, especially in France. Two forms of the disease have been recognized, that starting in the perichondrium and that in the cartilage itself. Because of the admittedly abundant vascularity of the perichondrium very little doubt has been expressed about the existence of tuberculous perichondritis. But this unanimity of opinion has been lacking when there has been discussion of tuberculosis of the central portion of the cartilage. The chief obstacle to belief has been the apparently widespread opinion that costal cartilage is avascular. It was with this idea that the reports of Mercadé,¹² Gruget¹³ and Dujarier,^{15, 16}

were attacked. And this in spite of the work of Linberg¹⁷ showing penetration of the cartilage with blood-vessels after the tenth year. More recently the studies of Nikolajew,¹⁸ and of Leblanc and Sayag¹⁹ have given adequate anatomical foundation for central hematogenous infection of the cartilage. Of the later reports of cases of tuberculous chondritis that of Benedetti-Valentini²⁰ is the most convincing. In his paper excellent photomicrographs of tubercles in the central portion of the cartilage are reproduced.

Whether or not the process is truly a primary one is mainly an academic question for the clinical course is quite constant. Two forms of onset are recognized, one starting in the perichondrium and the other starting in the cartilage proper. In the former there is at first a thickening of the perichondrium with the formation of tuberculous granulation tissue and pus, after which destruction of the cartilage ensues. Associated with this is the development of a soft-tissue swelling and the typical cold abscess appears. The process may remain localized with the formation of a sinus but the tendency is for it to spread along the cartilage with involvement of its corresponding rib, and even extension to other ribs. This tendency to spread is especially marked when the disease involves one of the lower ribs whose cartilages form a continuous bridge. Moschowitz²¹ said that the usual history of a patient with chondritis could be divided into four stages. During the first the soft-tissue abscess is treated by incision or is allowed to perforate, leaving a sinus. In the next stage laboratory investigation of the persisting sinus usually reveals tuberculosis. In the third stage, the stage of the curette, attempts at local eradication of the sinus are made. Finally comes the "stage of unsuccessful surgery," when multiple sinuses are present. Here wide excision of tissue is useless unless all of the cartilage in the involved area is removed from rib to sternum. As was repeatedly observed in his cases it was not the specific nature of the infection but rather the reaction of the specific tissue that made for chronicity. At secondary operations no evidence of tuberculosis could be found when all of the diseased cartilage had been removed at the first, but the remaining end of the cartilage was found to be denuded of its perichondrium and there was chronic chondritis. This tendency to chronicity can be best explained by the poor blood supply, the fact that the arteries are end arteries, and by the delicacy of the perichondrium. This last point was especially remarked upon by Moschowitz, who felt that the presence of a drain was sufficient to injure this tissue.

The diagnosis of this condition is especially important as it may be confused with typhoid chondritis, pyogenic infection, or syphilis. In the local examination of the part there is nothing specific. The history, the demonstration of the tubercle bacilli in smears or by growth on special culture media, or by guinea-pig inoculation, and the demonstration of tuberculosis elsewhere in the body are the points to be made.

The treatment of tuberculous chondritis needs great emphasis as it is usually notoriously inadequate. If conservatism is to be practiced then one

must be thoroughly conservative and depend upon general hygienic and heliotherapeutic measures. From a study of the recent literature, however, it seems evident that the only real hope for success lies in the addition of radical surgery. Although it was recognized by some that complete excision of cartilage was necessary it was not until 1918 when Moschowitz published his paper that the subject was clearly presented. Before that time most surgeons had been content to do local excisions of diseased cartilage, or a more radical resection, but still leaving exposed cartilage in the operative wound. These procedures were not infrequently temporarily successful but almost invariably recurrence ultimately occurred. In more recent years the teachings of Moschowitz have been widely followed and with a great increase in the percentage of cures. He showed the importance of complete removal of all of the costal cartilage in which the disease occurred, with partial resection of the bone at either end. Involvement of any rib below the fifth calls for subperichondrial resection of all of the lower costal cartilages as there is a continuous bridge between them. Having removed the cartilage the involved soft tissue must be as carefully excised as possible, meticulous hemostasis attended to, and the wound closed tightly. In extensive cases muscle pedicle grafts will be necessary. Drains should not be used in the absence of mixed infection, the accumulation of serum in the wound being combated by the firm pressure of the overlying dressing.

During the last three years I have had the opportunity of treating three cases of localized tuberculosis of the chest-wall. Because of their value in illustrating points discussed in the preceding paragraphs these cases are here reported.

CASE I.—E. C., a thirty-year-old white woman, a pupil nurse, first had evidence of pulmonary trouble following an attack of influenza and pleurisy in 1920. She developed a productive cough, lost weight and ran an afternoon fever. Examination showed evidence of pulmonary tuberculosis and she was sent to a sanatorium. After eighteen months she was well enough to resume her nursing, which she continued until 1926, when another attack of influenza followed by pneumonia caused a relapse in her tuberculosis. She was finally admitted to the Blue Ridge Sanatorium June 1, 1928. At that time she had evidence of an advanced bilateral process. She improved after a poor beginning and was doing well until January 28, 1929, when she suddenly developed spontaneously an extensive interstitial emphysema with evidence of mediastinal involvement. After going steadily downhill she recovered rapidly following surgical drainage of the supraclavicular and infraclavicular emphysematous areas. In June of the same year there developed a small inflammatory area over the lower part of the sternum. By the twenty-ninth it had shown evidence of fluctuation and was aspirated. At this time six cubic centimetres of thick yellow fluid were aspirated. No organisms were found. Other aspirations were done and heliotherapy was used without signs of improvement. It was then decided to excise the area. July 24 this was done under local anæsthesia. At that time the process seemed to be confined entirely to the soft tissues over the lower end of the sternum; no communication with the bone could be found. The wound was packed open with iodoform gauze. Examination of the small amount of tissue removed at operation showed a diffuse tuberculous inflammation with large caseous areas and a moderate epithelioid reaction with hæmorrhage, giant cells, and secondary acute inflammation. Healing took place slowly but progressively until only a small sinus persisted,

which gave no evidence of healing. All forms of local treatment and heliotherapy were tried without success. Finally, it became evident that the sinus led down to a deeper structure, probably the costal cartilage. March 1, 1930, under gas and oxygen anaesthesia the old lesion was excised and a focus was found in the cartilage of the seventh rib about an inch from the sternum. This area was excised locally and the wound packed with vaseline gauze. Sections were only made from the soft tissues removed, the cartilage as such was not recognized. The pathologist's report was: "Sections of skin and subcutaneous tissue show apparently normal epidermis but the derma shows marked round-cell infiltration and dense hyalinized fibrous tissue. On one border there is a mass of old granulation tissue which shows round cells and polymorphonuclear infiltration. Beneath this and throughout it are a number of areas resembling tubercles with giant cells and epithelial cells. There is only slight evidence of any caseation. *Diagnosis*.—Tuberculous granulation tissue."

Again she returned to the sanatorium and local measures and heliotherapy were again applied. All of this time her pulmonary condition was showing no change but she had improved to such a point that she was without symptoms except for a slight cough at times and a tendency to develop fever on exertion. It was at last realized that the only chance for cure of the tuberculosis of the chest-wall lay in a radical removal of the lower cartilages. This was done July 8, 1930; the sixth, seventh, eighth, and ninth costal cartilages were excised. Examination of the tissue removed showed many pieces of rib, cartilage and fibrous tissue, and skin. Sections showed normal-appearing epithelium, but the subcutaneous tissue was infiltrated with polymorphonuclear round cells and red blood-cells with many tubercles. There was marked increase of fibrous tissue. Sections of the cartilage and bone showed no evidence of tuberculosis but slight acute and marked chronic inflammation with many giant cells. *Diagnosis*.—Acute and chronic inflammation of skin with tubercles in the subcutaneous tissue. Acute and chronic osteochondritis.

The wound healed quite well, being almost entirely closed except for the site of the old wound by the end of the second week. At this time she began having frequent headaches and generalized dull pains. After three days she showed evidence of meningeal irritation with increased spinal fluid pressure (200 millimetres water) and 146 cells per cubic millimetre but tubercle bacilli could not be demonstrated. She went rapidly downhill and died July 30, just twenty-two days after her operation. Permission for autopsy was refused.

Comment.—This case was of extraordinary interest throughout and it was most disappointing that a final examination could not be made. The origin and course of her spontaneous interstitial emphysema have been discussed in an earlier paper.²² Apparently, there was no direct connection between her intrathoracic tuberculosis and that of her chest-wall. In retrospect, it would seem that she had a tuberculous focus in her costal cartilage from the beginning and that it was overlooked at the first operation. The inward extension of a soft-tissue tuberculosis to the cartilage is not on record where there has been excision of the process without damage to the underlying cartilage. That no damage could have been done to the cartilage at the first operation on this patient is certain as the procedure was confined to exploring the inflammatory process which was located over the lower part of the sternum. The first operative procedure would seem to have been adequate though an attempt at closure of the wound would have been better. At the second operation when cartilage was found to be exposed and diseased the radical procedure carried out at the last operation should have been done. Failure to do so was partly due to the patient's fear of an operation of any extent and to my own feeling that a local procedure might suffice. The fatal outcome in this case was probably associated with the operation. She had an advanced pulmonary lesion and the addition of extensive trauma was sufficient to cause a flare-up in her pulmonary lesion and spread to her meninges, or brain. Such a fatal ending was reported by Moschowitz in one of his cases. Whether such an operation should be urged upon a

TUBERCULOSIS OF THE CHEST-WALL

patient with the marked pulmonary involvement that this patient had is a debatable question. As can be seen from this report conservative treatment was followed for a long time. After months of having a small draining sinus this patient became so depressed at the thought of its persistence, even though it was neither painful nor in any noticeable position, that she said that she would rather die than live with it ever present. Although she had widespread involvement of her lungs the process had reached a semi-quiescent state, she had no tubercles in her sputum and with rest ran no fever. She was to be discharged from the sanatorium when she begged to have another attempt made to eradicate her chest-wall lesion.

CASE II.—S. M. H., a thirty-nine-year-old white railroad fireman, was admitted to the University of Virginia Hospital May 26, 1930, because of draining sinuses of his right chest-wall. Four or five years before admission he had developed a right-sided pleurisy with effusion and was in bed for five months. Eighteen months later he worked for a short time and then developed a tuberculous cervical adenitis, also on the right side, which responded to simple drainage. In December, 1928, he was admitted to the medical service of the University of Virginia Hospital, at which time he was found to have a right cervical adenitis, a large abscess of the right chest-wall, a greatly thickened pleura and röntgenographical evidence of an old tuberculous process of the right apex. Aspiration of the abscess revealed clear yellow fluid which contained tubercle bacilli. He returned home and under general hygienic treatment improved in every way. The abscess opened spontaneously and drained clear fluid from the sinus which had developed at the site of the original aspiration. Later, two other sinuses formed near the sternum and were used by his doctor for purposes of irrigation. Upon return to the hospital in May, 1930, he was found to have evidence of an old healed right cervical tuberculous adenitis, retraction of the upper half of the right chest, and a chronic abscess occupying the right chest-wall with old sinuses located at the anterior axillary line over the fourth rib, near the sternal end of the same rib and over the sternal end of the third rib. There was free communication between these with evidence of a large central extrapleural cavity. Röntgenographical examination of the chest showed evidence of an old tuberculosis of the right apex, marked thickening of the entire right pleura and a small area of rarefaction in the centre of a mass of increased density corresponding to the sternal end of the right fourth rib.

May 29, under gas and oxygen anæsthesia, an incision was made connecting the three sinuses. This opened into a large abscess cavity which extended under the pectoral muscles, and involved parts of the cartilages of the third and fourth ribs which were ragged in appearance. The sternal end of the fourth rib showed evidence of necrosis. The intervening soft parts were almost cartilaginous in consistency. There was a rather large amount of thin purulent fluid material. All of the cartilage of the involved ribs together with the terminal two inches of bone was resected. The intervening soft tissues were excised as completely as possible but the pleura was not exposed due to the greatly thickened endothoracic fascia.

Examination of the tissue removed at operation showed small pieces of roughened cartilage, of normal-looking rib, a piece of rib with an irregular cavity containing soft translucent tissue and pieces of skin and fibromuscular tissue. Section of the soft tissues showed much dense fibrous tissue with round-cell infiltration and large portions of a more cellular granulation tissue, showing numerous small tubercles. In the latter portion were also numerous polymorphonuclears. A few areas of necrosis were present. Section of the cartilage showed inflammation of a somewhat atypical nature but with no evidence of tuberculosis. The bone, due to a misunderstanding, was not sectioned, and the specimen lost.

The patient made a good recovery from his operation. The wound drained freely at first but drainage decreased rapidly under daily dressings and ultra-violet-light therapy until his departure from the hospital nineteen days after operation. At that time the wound was mainly healed except for the lowermost portion, from which there

escaped seropurulent fluid. The patient was allowed to return home with the understanding that he would receive ultra-violet-light therapy and have other proper care.

After returning home he continued to improve. His wound was solidly healed by November and remained so until the following April. At this time a sinus reappeared. His general condition had continued to be good. Since then I have been unable to get in communication with him.

Comment.—The origin in this case seems definitely to have been in the lymphatics of the chest-wall. As a result of his pleurisy the lymphatics became involved but did not give rise to the chest-wall abscess until the intrapleural disease had become dormant. The appearance of the sinus at the site of the aspiration is typical and illustrates the importance of using proper technic as previously described. The delay in healing was probably due to a combination of circumstances, mixed infection, incomplete removal of diseased tissue, and failure to fully obliterate dead space.

CASE III.—J. M., a white taxi driver of thirty-two years, was first seen in the Chest Clinic of the Episcopal Hospital, Philadelphia, February, 1931. During the course of his routine chest examination it was noticed that he had an oval swelling in his lower chest, overlying the eighth rib at its costochondral junction. He had noticed this swelling for a few weeks but because of lack of pain had said nothing about it. In 1928, this patient had been found to have a bilateral pulmonary tuberculosis and had been sent to a sanatorium, from which he had been discharged as a quiescent case in May, 1930. Since that time he had been working, as a taxi driver, with no symptoms except for a slight morning cough.

Examination of the chest showed a typical cold abscess in an early stage occupying the region above described. It was about two inches in greatest diameter, was soft and deeply fluctuant, not tender and the overlying skin was normal. There were also signs of disease at both apices, with moderately coarse râles after cough, and slight dullness.

Aspiration of the swelling through the surrounding edge of normal tissue gave a clear, straw-colored fluid which contained no pus and no bacteria. Guinea-pig inoculation also was negative.

He was admitted to the Episcopal Hospital February 25. A röntgenogram of his chest showed evidence of an old bilateral apical tuberculosis but no evidence of rib involvement was seen. February 26, under local anæsthesia, an incision was made over the dome of the swelling starting an inch lateral to it and extending an inch medial to it. The mass was found to be an abscess arising from the tissue immediately overlying the costal cartilage near the costal junction. In excising it a small opening was made in its wall and a creamy pus escaped. The wound was cleaned and then the distal inch of the rib and the proximal inch of the cartilage were resected and their ends covered with bone wax. It was thought then that the process was arising from the perichondrium. The muscles were carefully approximated as well as the subcutaneous tissue and skin. A small rubber dam drain was inserted in the outer angle of the wound and a firm dressing of gauze was applied. Convalescence was uneventful, the wound healing by primary intention except at the site of the drain. He was discharged March 7 nine days after operation.

Microscopical examination of the tissue removed at operation showed no involvement of the rib or cartilage but tuberculous granulation tissue. It could not be determined whether it arose in the perichondrium, or the overlying connective tissue.

The patient now has a small scar which gives him no trouble and shows no evidence of breaking down. His general health has continued to be good.

Comment.—Prompt detection of the abscess in this case was due entirely to a routine examination. It was in a very early stage and most suitable for operative intervention. The rapidity with which healing took place and the fact that the remaining cartilage did not become involved suggest that the process was completely removed and that the

TUBERCULOSIS OF THE CHEST-WALL

cartilage had not been primarily affected. There seems to be no evidence here of lymphatic extension from a deeper focus.

Usually such a case would not reach a surgeon until after the abscess had been repeatedly aspirated or had spontaneously opened; then the story of healing would not have been so smooth.

Summary.—There is a striking difference in the number of cases of localized chest-wall tuberculosis seen in hospital practice. This can be accounted for by the difference in attitude of the doctors referring patients to surgeons.

The process may arise by extension from foci in the lymphatics of the chest-wall, or as a hematogenous infection.

In order of frequency the bony ribs come first, the sternum, and soft parts next, and the cartilage last.

Diagnosis can rarely be made before the cold abscess appears. Examination of its contents will almost invariably settle the question.

Treatment must be general and local. Excellent results have been obtained by radical excision well beyond the limits of the involved tissue, removal of all exposed cartilage, and air-tight closure. Drainage should be used only in cases with mixed infection.

Three new cases of localized chest-wall tuberculosis are reported.

BIBLIOGRAPHY

- ¹ Graham, E. A.: *Surgical Diagnosis*. W. B. Saunders Company, vol. iii, p. 21, Philadelphia, 1930.
- ² Riedinger, and Kümmell: Quoted by Heuer.⁵ Also see: *A System of Practical Surgery*, E. von Bergman, P. von Bruns, and J. von Mikulicz, editors. Translated by Wm. T. Bull and C. P. Flint, vol. ii, Lea Brothers and Company, Philadelphia, 1904.
- ³ Sorrell, and Me. Sayag-Dromer: *Abcès froids thoraciques*. *Arch. méd.-chir. de l'app. respir.*, vol. iv, pp. 314–330, 1929.
- ⁴ Alexander, John: Personal communication.
- ⁵ Heuer, G. J.: *Nelson Loose-Leaf Living Surgery*, Thos. Nelson and Sons, vol. iv, pp. 393–394, 406–413, New York, 1928.
- ⁶ Richard, A.: *Traitement des abcès froids de la paroi thoracique*. *Rév. med. franç.*, vol. xi, pp. 813–815, 1930.
- ⁷ Ito, H.: *Zur operativen Behandlung der Pericostaltuberkulose*. *Deutz. Zeit. f. Chir.*, vol. clxxxv, pp. 124–128, 1924.
- ⁸ Kaufmann, R.: *Pathogenie des abcès froids du thorax*. *Ann. d'anat. path.*, vol. vii, p. 1002, 1930.
- ⁹ Kaufmann, R.: *Quelques considerations sur l'abcès froid thoracique*. *J. de chir.*, vol. xxxvii, pp. 829–841, 1931.
- ¹⁰ Ricard, A.: *Abcès froids de la paroi thoracique d'origine chondrale*. *Lyon chir.*, vol. xxvi, pp. 233–238, 1929.
- ¹¹ Auchincloss, Hugh: *Tuberculous Abscesses of the Chest-wall*. *ANNALS OF SURGERY*, vol. lxxv, pp. 404–417, 1922.
- ¹² Mercadé, Salva: *Tuberculose des cartilages costaux*. *J. de chir.*, vol. xii, pp. 159–181, 1914.
- ¹³ Gruget, A.: *Sur la tuberculose primitive des cartilages costaux*. *Rev. de chir.*, vol. lix, pp. 33–39, Paris, 1921.

- ¹⁴ Aloï, V.: Tuberculoma Mammario D'Origine Costale. *Riforma Med.*, vol. xlv, p. 33, 1928.
- ¹⁵ Dujarier, Ch.: Abscès froids thoraciques à point de départ chondral. *Bull. et mem. Soc. nat. de chir.*, vol. I, p. 1171, 1924.
- ¹⁶ Dujarier, Ch.: À propos de l'origine chondrale de certain abscess froids thoraciques. *Bull. et mem. Soc. nat. de chir.*, vol. li, p. 93, 1925.
- ¹⁷ Linberg: Quoted by Sorrell and Me. Sayag-Dromer.
- ¹⁸ Nikolajew, O.: Zur Frage über die Gefassversorgung der Rippenknorpel. *Zentral. f. Chir.*, vol. liii, pp. 1688-1690, 1926.
- ¹⁹ Leblanc, E., and Mlle. F. Sayag: Note sur la vascularisation des cartilages costaux. *Ann. d'anat. path.*, vol. iv, pp. 569-570, 1927.
- ²⁰ Benedetti-Valentini, F.: La Cura Radicale Degli Ascessi Freddi Condrifluenti Della Parete Toracica. *Policlinico (sez. chir.)*, vol. xxxvii, pp. 417-431, 1930.
- ²¹ Moschowitz, A. V.: The Treatment of Diseases of the Costal Cartilages. *ANNALS OF SURGERY*, vol. lxviii, pp. 168-182, 1918.
- ²² Meade, Jr., R. H., and Stafford, F. B.: Spontaneous Interstitial Emphysema in Pulmonary Tuberculosis; Report of a Case Successfully Treated by Operation. *Am. Rev. Tuberc.*, vol. xxi, pp. 579-586, 1930.

THE FULL-THICKNESS SKIN GRAFT

ITS FIELD OF APPLICABILITY AND TECHNICAL CONSIDERATIONS*

By JOHN H. GARLOCK, M.D.

OF NEW YORK, N. Y.

ALTHOUGH evidence indicates that the ancients made use of this form of skin grafting, the earliest authentic record was by J. Mason Warren, in 1843. Wolfe, in 1875, introduced the method to ophthalmological literature, while Kraus, a year later, called attention to its possibilities in general surgery. The more modern aspects of the subject have been developed largely by J. Staige Davis and V. P. Blair. While, since Warren's first report, this method has been used frequently, it still remains a surgical resource of great value to a relatively small group of surgeons. Therefore, I would like to call attention again to its possibilities and to enumerate some of the problems, many of a technical nature, that have been encountered.

Inasmuch as the success of a full-thickness skin graft depends largely upon an almost perfect aseptic technic, it may be stated that this type of graft should be placed only on a fresh surgical wound and that its use for granulating wounds is inadvisable. Its field of applicability is therefore limited to a group of cases which present a defect of skin and subcutaneous tissues immediately following surgical excision of a pathological condition. These may be divided into several classes; namely, following excision of healed cicatricial contractures caused by burns or trauma, after plastic or destructive operative procedures to prevent cosmetic defect or contractural deformity, to replace skin loss following excision of surface tumors or blemishes, to furnish skin for the clefts in the operation for congenital or acquired syndactylism, and to replace hair-bearing skin, as an eyebrow.

The convalescence of a patient with a large granulating wound may be greatly shortened by the early application of Thiersch grafts, a point stressed by Lyle. Besides diminishing the extent of underlying fibrosis, which, in itself, is most important, early Thiersch grafting curtails the period of convalescence and the number of painful dressings. At a later date, if contractural deformities develop, the full-thickness skin graft may be used following excision of the scar.

In the selection of the type of skin graft to be used in a particular case, the surgeon must take cognizance of a number of factors. There are numerous conditions in certain parts of the body which require for their correction more underlying tissue than a full-thickness graft can supply. Under such circumstances, the pedicled skin flap offers greater possibilities. Certain regions, as the neck and axilla, are so constituted anatomically as to lend themselves poorly to prolonged immobilization and firm, even pressure, two

* Read before the New York Surgical Society, May 11, 1932.

factors which are so necessary for the success of the full-thickness graft. In the neck, the constant motion of the thyroid cartilage in the act of swal-

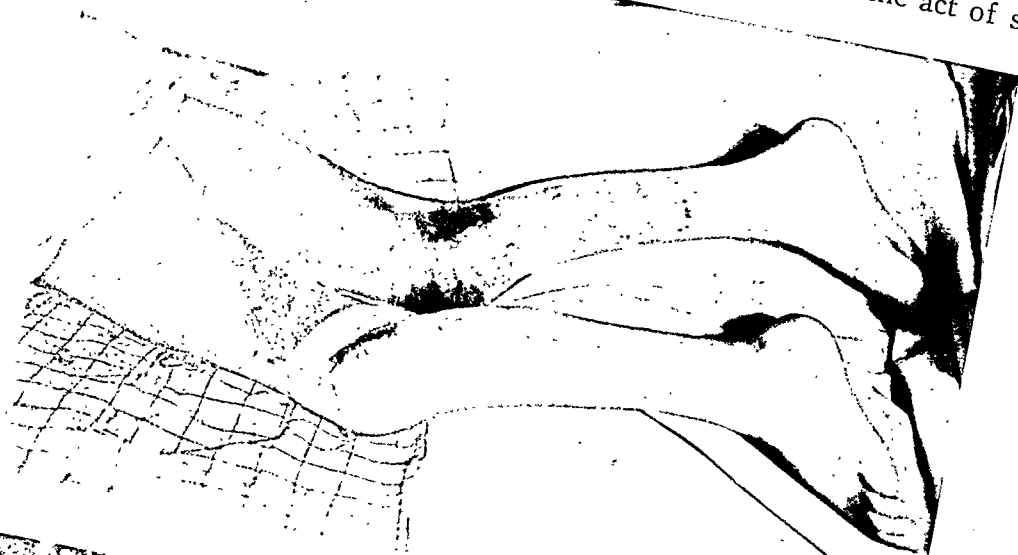


FIG. 1.



FIG. 2.

FIGS. 1 and 2.—This boy, eight years of age, was admitted to the New York Hospital six months after he had sustained severe burns of the legs when an Indian suit which he was wearing caught fire. He was taken to a hospital soon after the accident, where he remained for six months. There con- tratures of both popliteal spaces were allowed to develop. The child appeared chronically ill and screamed with pain when dressings were attempted. There was a large granulating area in each popliteal space. The knees were flexed to a right angle. The legs were placed in traction. On October 16, 1929, following the preparation of the granulating areas, a pedicled flap was raised from the posterior aspect of the left thigh, the pedicle being situated over the outer aspect of the knee. The scar tissue in the left popliteal space was excised and the flap placed transversely into the defect. The flap measured one and a half inches by three and a half inches. A plaster splint held the knee in extension. The distal one inch of this flap sloughed.

lowing accounts for the reported instances of necrosis of the graft at this site. In the axilla, the irregular depth contour of the wound following excision of

FULL-THICKNESS SKIN GRAFT

a cicatrix makes firm, even pressure difficult. In other regions, as the back of the neck, the forehead and face, and parts of the torso, the full-thickness graft can be used with excellent chances of success. However, this form of graft finds its greatest field of usefulness in extremity surgery. To cover defects in the popliteal space, the front of the elbow, the forearm and leg, and both aspects of the hand, the surgeon has in the full-thickness graft a



FIG. 3.—Three weeks later, the pedicle of the flap was divided and sutured into place. Thiersch grafts were then applied to the defect along the inner side where the flap had sloughed. At this same sitting, a tubed flap was made on the anterior aspect of the right thigh. This was subsequently "waltzed" to the inner aspect of the right knee in preparation for use in the right popliteal space. However, the house surgeon, in removing the bandage one day, accidentally divided the flap in two; so that this procedure had to be abandoned. The granulating area in the right popliteal space and the contracture are clearly shown.

most valuable surgical recourse. In addition to supplying adequate tissue, it has the added advantage of a one-stage procedure. Even in extremity surgery, certain minor limitations to its use must be considered. For instance, a full-thickness graft will not unite to bone, unless a layer of periosteum is present. On the flexor surfaces of the fingers, this form of graft will very

often not succeed if placed upon exposed tendons. An intact tendon sheath is most desirable.

There are other considerations, more remote in point of development, which must also be analyzed before the surgeon makes use of a full-thickness graft. These involve future shrinkage, changes in color, the development of heavy scars at the edges and the growth of hair. With regard to shrinkage, it has been my experience that, if the graft "takes" perfectly with a minimum loss of surface epithelium, the contraction will not be more than would follow the healing of a pedunculated flap of similar size. In certain regions, allowance must be made for any shrinkage with a view toward future func-



FIG. 4.—One month later, a full-thickness graft taken from the left buttock was applied to the inner half of the left popliteal space marking the region where the original pedicled flap had sloughed. This graft measured two inches square. It was not perforated. Xeroform-rubber sponge dressing was applied. First dressing was done on the twelfth post-operative day. The graft "took" entirely. One month later the granulating area in the right popliteal space was covered with Thiersch grafts. The patient was then discharged and returned one year later. The photographs indicate the contracting scar in the right popliteal space and the soft pliable skin in the left popliteal region.

tion. For instance, when a Wolfe graft is placed on the dorsum of the hand, the fingers should be placed in flexion during the period of healing in order to prevent future loss of function. In certain locations, Blair speaks of doubling back the skin bordering the defect at the time of operation in order to compensate for expected contraction. On the hand, splints used for two or three weeks will help control contraction.

With regard to late changes in color, numerous interesting observations have been made. In true blonds, very little, if any, later pigmentation occurs. Brunettes show a much greater tendency to pigmentary changes. This is

FULL-THICKNESS SKIN GRAFT

more prone to occur if superficial exfoliation of the uppermost epithelial layers takes place. A good "take" without this surface blistering shows grossly very little change from the normal skin texture of the original source of the graft. Finally, full-thickness grafts have a tendency to develop a "shiny" appearance, which must be considered when using the method for face defects.

Not infrequently, a heavy scar will develop along the edges of the graft.



FIG. 5.

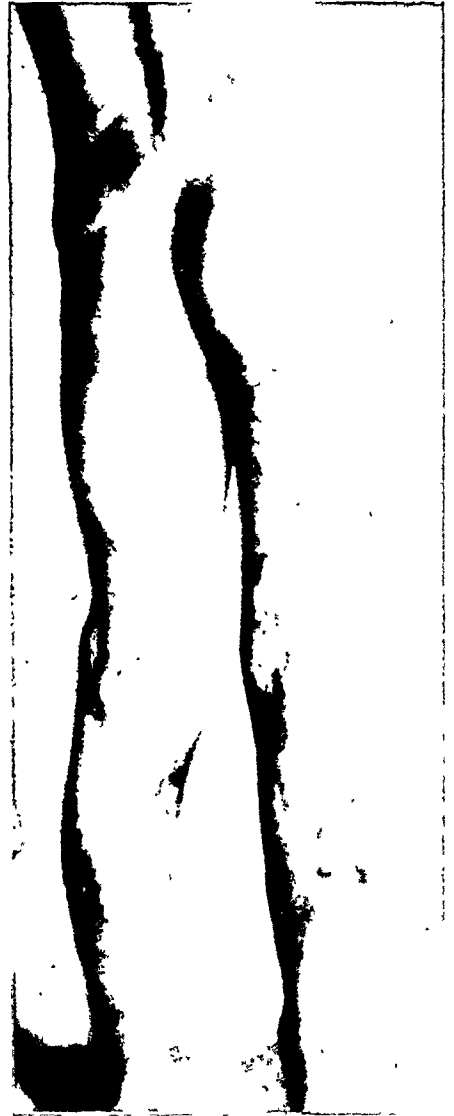


FIG. 6.

FIG. 5.—A free full-thickness graft taken from the lower lumbar region, and measuring three by five inches, was placed in the right popliteal space after excision of the contracting scar. No perforation of the graft was done. Xeroform ointment and rubber sponge dressing. Photograph indicates a tiny slough near the outer inner angle.

FIG. 6.—This indicates the final result. The photograph was taken two and a half years after the last operation. The skin in each popliteal space is soft and pliable, and is not pigmented. There is normal function in the knee-joints.

This may occur after a perfect "take." It is difficult to explain this remote development, unless the reason may be the indefinite one that causes some individuals to form keloids after simple incisions. Needless to say, one cannot foretell this eventuality.

I have noted, in almost every instance, that, three or four months later,

a thin layer of fatty tissue is deposited beneath the graft, and a previously depressed area fills up and rises to the level of the surrounding skin. Thus, the full-thickness graft possesses another important advantage. Inasmuch as the majority of hair follicles in a successful "take" will grow hair, the surgeon must choose non-hair-bearing skin, unless hair is desired. This is important.

The most recent study of the histology of skin grafts is by Harold Neuhof, in his monograph, "Transplantation of Tissues." I believe that a clear understanding of the healing processes and tissue changes is so important that a brief summary of his findings is indicated. Within five or six hours after transplantation, there is an exudate

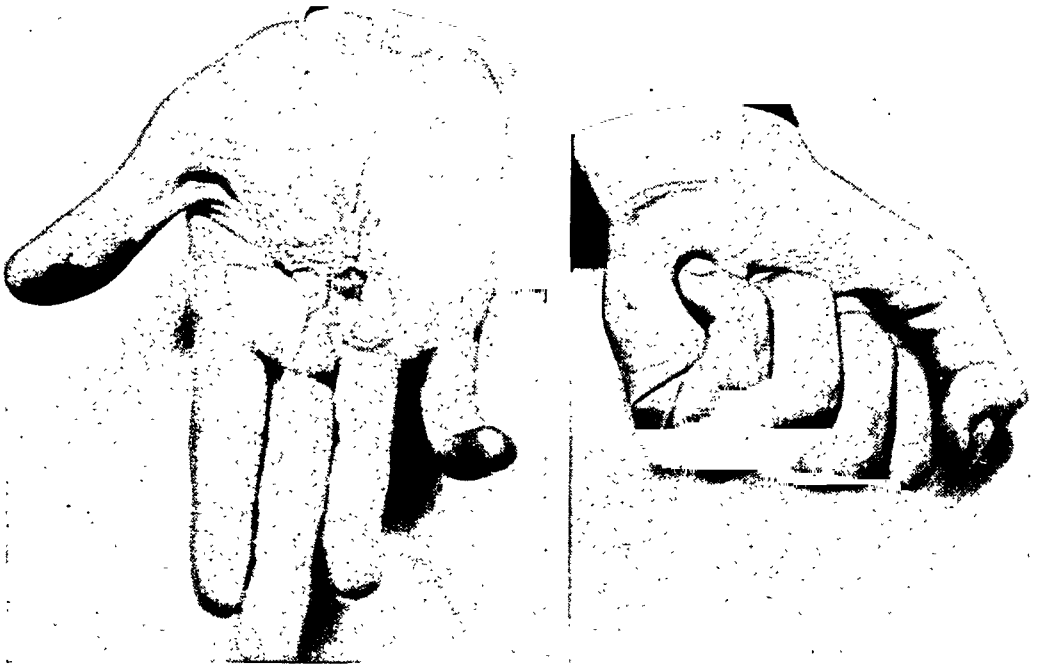


FIG. 7.—This patient caught his left hand in a machine on September 18, 1929, producing an injury in the palm. He was taken to a hospital where an operation was performed the following day. The wound became infected, necessitating two subsequent operations. The wounds healed after twelve weeks. The patient presented an irregular contracting scar in the palm of the left hand, stretching from the base of the ring finger to the base of the thumb, pulling the thumb toward the palm. There was bony ankylosis of the proximal interphalangeal joint of the little finger due to a badly united fracture. The ring finger was held in partial flexion and there was marked impairment of active flexion in the middle and ring fingers. On July 1, 1930, the entire scar in the palm of the hand was excised. Extensive scar tissue binding the various flexor tendons together was visualized. This was completely removed. A sleeve of paratenon fat taken from the palmaris longus tendon was placed around the flexor profundus tendons of the ring and middle fingers. The defect was then covered with a free full-thickness skin graft taken from the anterior chest-wall. The hand was placed on a specially prepared aluminum splint with the fingers in extension and wide abduction. The graft was not perforated. Xeroform ointment-rubber sponge dressing was applied. The first dressing was done on the eleventh post-operative day. A small area of necrosis developed in the centre of the graft. This pictures the result after two years, and illustrates the thick peripheral scar as well as a keloid formation at the point of necrosis.

of fibrin from the underlying wound fixing the transplant in place. This fibrin layer soon becomes infiltrated with leucocytes and fibroblasts and disappears gradually, being replaced by a richly vascular connective tissue containing round cells. The granulation tissue has changed into an organized membrane at about two weeks. Within a few hours after the grafting operation, leucocytes of the fibrin layer migrate into the interstices of the graft and are also found in the lumina of its empty blood-vessels. Most of the vessels in the transplant degenerate. By injection experiments, vessels have been

FULL-THICKNESS SKIN GRAFT

demonstrated in grafts on the third day. I have demonstrated this point, clinically, by obtaining bleeding from a free full-thickness graft after forty-eight to fifty-six hours by scarifying its surface. The newly built vessels arise by a budding of the capillaries in the fibrin layer and the buds often extend directly into the vessels of the graft. The latter histological finding is evidence in favor of suturing full-thickness grafts under some tension so as to favor keeping open the cut ends of blood-vessels and lymphatic channels.

Degenerative processes begin, and by the third or fourth day the epidermis with the upper rete layer is lost. At an early date, vacuolization of the surface of the graft is evident. Hand in hand with the degenerative processes, regeneration goes on and it is usually so energetic that in six or eight days, the entire transplant is covered with new epithelium. The degeneration extends to the cutis, also. Padgett, working in



FIG. 8.



FIG. 9.

FIG. 8.—The scar on the chest-wall marking the donor site for the full-thickness graft.

FIG. 9.—This patient, when first seen on January 7, 1931, presented a large neurofibroma on the antero-internal aspect of the left leg which he had had for twelve or thirteen years. The tumor was completely excised, leaving an oval defect measuring three inches in diameter, and two and a half inches in length. In order to completely eradicate the growth, a small piece of periosteum was removed from the tibia. A full-thickness skin graft taken from the anterior aspect of the same thigh was placed in the defect. It was not perforated. Xeroform ointment-rubber sponge dressing. The graft "took" completely with the exception of the region which covered the tibia where the periosteum had been removed. The photograph indicates the result after fifteen months, and shows that the area which had been previously depressed is now level with the surrounding skin due to the deposition of fat.

Blair's clinic, found that his sections did not show as much degeneration of surface epithelium or cutis and corium as is usually described.

Technic.—It is probably wiser to completely excise a cicatrix than to make relaxing incisions only. Naturally, if the area produced by total excision of the cicatrix were to be too extensive, such a procedure would not be feasible. In extremity surgery, the use of an Esmarch bandage is an



FIG. 10.—This patient received a severe injury to the right hand on November 10, 1930, when it was caught in a silk machine. He was treated in a hospital out of town for one and a half months. Five months after the injury examination showed a thick ridged scar extending from the wrist to the proximal phalanx of the ring finger, producing a contracture of the entire palm, drawing all the fingers together toward the middle of the palm. X-ray revealed a healed fracture of the proximal phalanx of the little finger united in poor position. The photographs indicate the extent of function before operation.

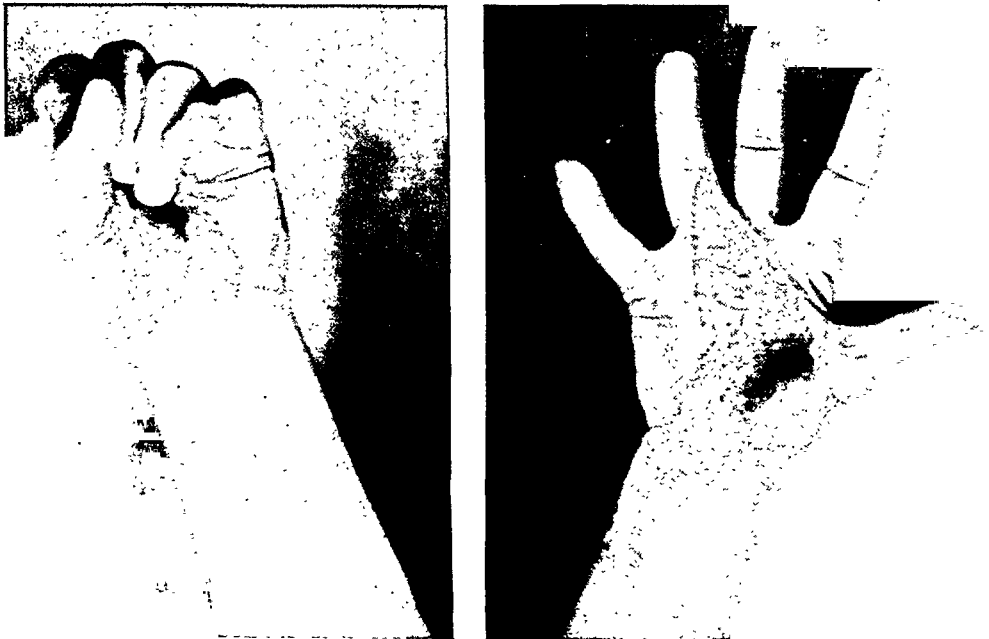


FIG. 11.—On March 24, 1931, the entire scar was excised, thus permitting complete extension of the fingers. The defect measured five by three inches. A free full-thickness skin graft taken from the chest-wall was applied. The graft was not perforated. The hand was placed on a specially prepared aluminum splint with the fingers extended and widely abducted. Xeroform ointment-rubber sponge dressing. The graft "took" completely. The first dressing was done on the thirteenth post-operative day. The splint was worn for three weeks. The photographs indicate the thick scar along the outer distal aspect of the palm. In addition, the deep pigmentation is noteworthy. This was expected because the patient is very dark complexioned. The improvement in function is noteworthy.

FULL-THICKNESS SKIN GRAFT

added advantage, because it permits of more rapid excision of the cicatrix and diminishes, to a large extent, tissue trauma. After excision of the scar,

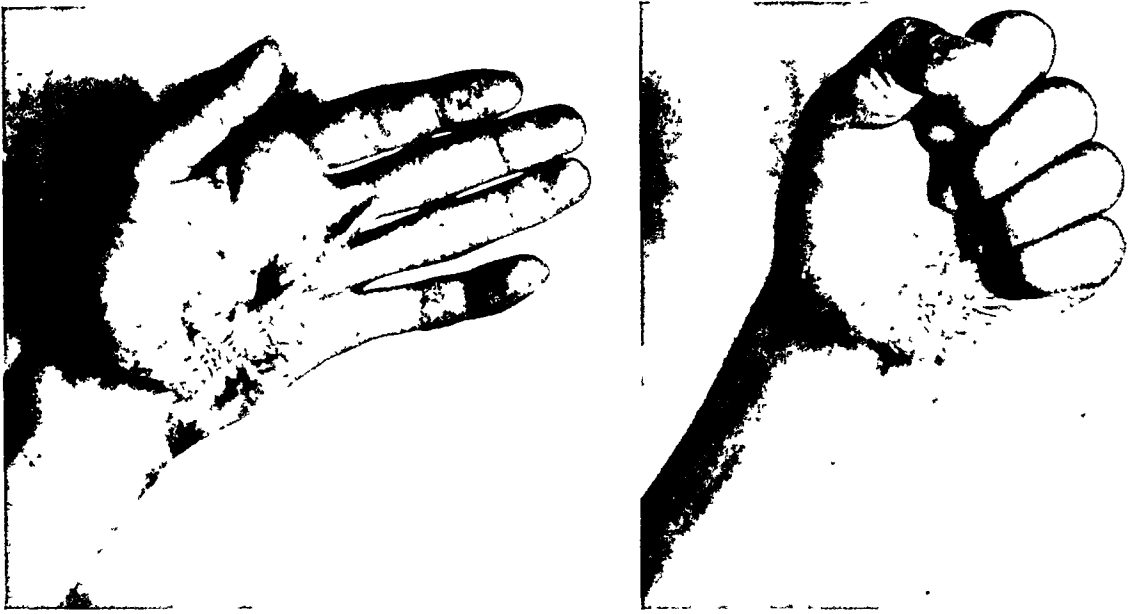


FIG. 12.—This patient injured his left hand on August 31, 1931, when it was caught in a bread machine. The patient was taken to a hospital where the wounds were sutured. A mild infection developed producing an extensive cicatrix as indicated in the photographs. This scar prevented extension of the little, ring, and middle fingers and full abduction of the thumb.

the Esmarch bandage is removed and bleeding is controlled. The capillary bleeding that always occurs can usually be controlled by having an assistant apply firm, even pressure with warm sponges while the surgeon removes the



FIG. 13.—On October 27, 1931, the entire scar was excised. Scar tissue was found extending into the palm, binding the various digital nerves together and running into the muscles of the thenar eminence. The defect was covered by a non-perforated full-thickness skin graft taken from the chest-wall. The hand was placed on an aluminum splint with the fingers widely abducted and extended. Xeroform ointment-rubber sponge dressing. Aside from superficial exfoliation of the surface epithelium, the entire graft "took" without incident. The photographs indicate the return of complete function, and the peculiar mottled pigmentation in a patient who is moderately dark skinned.

graft from the donor site. Before the graft is applied, the wound should be absolutely dry. This is probably the most important feature of the opera-

tive technic. In securing bleeding points, triple-zero plain catgut is used. Fear of possible harm to the graft by burying many tiny knots of catgut in the wound bed should not deter the surgeon from obtaining absolute hæmostasis. I have not seen any complications which could be ascribed to this practice.

It is advisable to undermine the edges of the wound to be grafted in order to obtain more accurate edge-to-edge apposition. This manœuvre also helps to diminish future contraction of the graft and probably lessens the likelihood of a heavy peripheral scar.

A pattern accurately reproducing the size and shape of the wound is next made. Numerous methods have been proposed to expedite this step. Blair uses tinfoil. Others use rubber dam. For the past three or four years, I

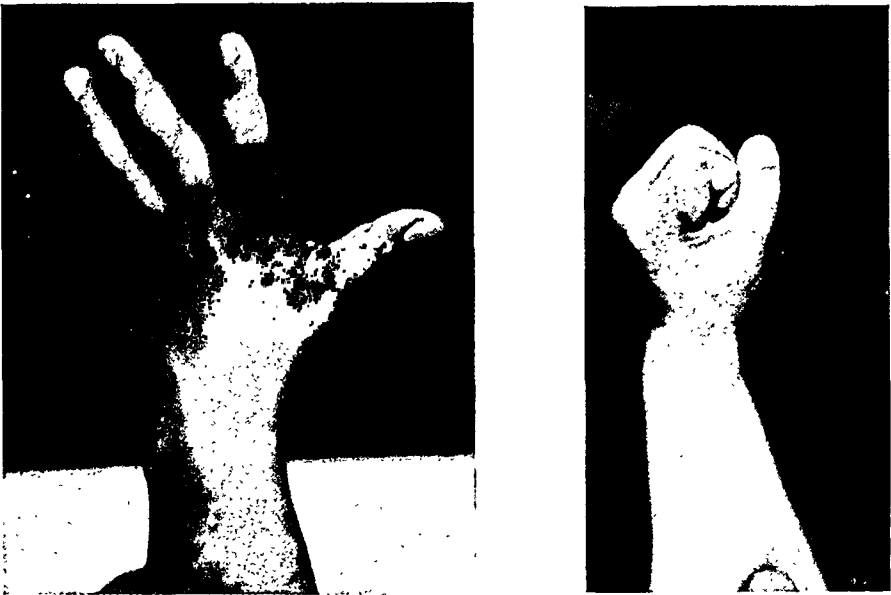


FIG. 14.—This child, two years of age, burned his left hand when a hot iron fell on it. The burned area healed producing a syndactylism between the thumb and index finger, with obliteration of the first web and part of the web between the index and middle fingers. The entire scar was excised, thus freeing the webs between the involved fingers. The hand was then placed on a specially prepared aluminum splint with the fingers widely abducted. A non-perforated free full-thickness skin graft taken from the left thigh was placed into the defect and xeroform ointment-rubber sponge dressing applied. The first dressing was done on the eleventh post-operative day. The graft "took" completely. The splint was worn for two and a half weeks. The pigmentation indicated in one photograph is an artefact. The grafted area is hardly distinguishable from the surrounding skin, as indicated in one of the photographs.

have been using stiff paraffin mesh gauze with the idea that the perforations in the gauze aided the surgeon in visualizing more clearly the underlying wound while cutting the pattern. In the December, 1931, issue of the Archives of Surgery, Davis and Kitlowski described another method which makes use of perforated cellosilk and brilliant green dye to outline the size of the pattern. The skin from which the graft is to be obtained is painted with $3\frac{1}{2}$ per cent. iodine and is washed off with alcohol. The pattern is laid on the skin, epithelial surface up, and the outline is most accurately marked out with the point of a toothpick dipped in methylene blue or brilliant green solution. Using a very sharp small knife, the painted outline is

FULL-THICKNESS SKIN GRAFT

then incised down through the full thickness of the skin. Believing that any form of trauma, however slight, will lessen the chances for a successful



FIG. 15.—This patient caught his left hand in a dough roller producing a severe crushing injury of the index, middle, and ring fingers. He was admitted to the New York Hospital soon afterwards, presenting extensive lacerations with "spreading effect," involving the anterior aspects of these three fingers. The tendon sheaths were opened and the tendons exposed for a distance of one and a half inches. The patient was operated upon soon after admission. The wounds were thoroughly debrided and sutured *loosely*. Active motion was started the next day and the wounds healed without incident. The photographs indicate the appearance of the fingers on the tenth post-operative day. The scars subsequently produced a mild flexion contracture of the middle and ring fingers.

"take," a technic has been developed which permits of no grasping of the graft by any instrument. Although this is rather tedious, the results have

justified this feature. A tiny hook is made to catch one corner of the graft, and, with this as a tractor, the cutting of the graft is initiated. As its removal proceeds, additional hooks may be placed at cardinal points to facilitate the operation. The undersurface of the skin should be free of fat and show

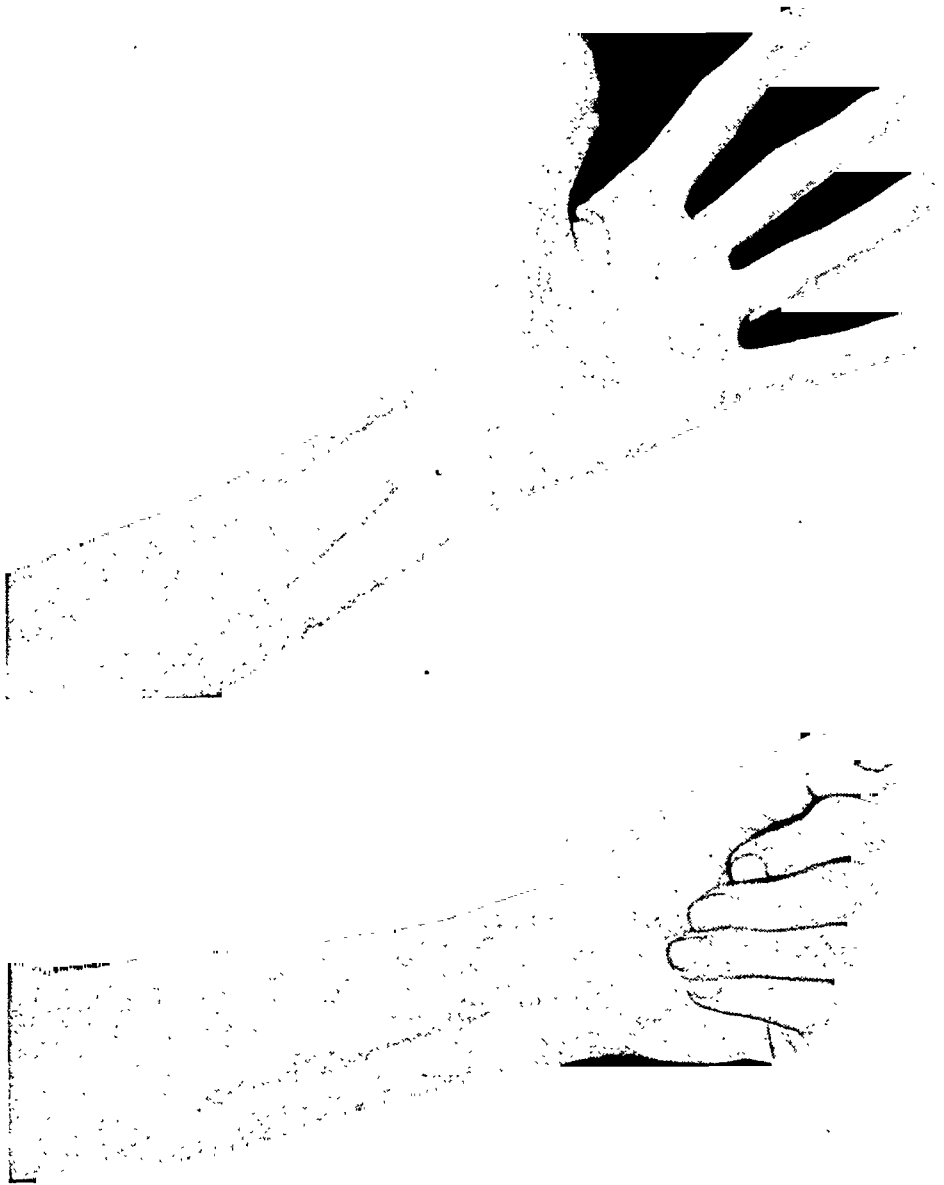


FIG. 16.—Accordingly, six months later these scars were excised without exposing the tendons. Free full-thickness skin grafts taken from the front of the forearm were inserted into the defects. The fingers were placed in extension on tongue depressor splints, and xeroform-rubber sponge dressings were applied. The first dressing was done on the seventh post-operative day. Each graft "took" completely. The fingers were immobilized for two and a half weeks. The photographs indicate the lack of pigmentation in a patient who is blond.

white and stippled with tiny depressions. After its removal, the graft, still held by one or two hooks, is placed raw surface downward, on a warm, moist gauze pad. All these precautions are taken because I feel that a tech-

FULL-THICKNESS SKIN GRAFT

nic which tends to eliminate trauma will obtain the highest percentage of perfect "takes," provided asepsis is rigid and hæmostasis complete.



FIG. 17.—This patient received a severe crushing injury six months before. This produced an extensive contracting scar on the dorsum of the left hand which had drawn the fingers in hyper-extension, producing pathological dislocation of the metacarpo-phalangeal joints of the four fingers. The anterior aspect of the hand was negative. At operation the entire constricting scar was excised. The metacarpo-phalangeal joints were brought into flexion only after the collateral ligaments were divided. The entire area was covered with a perforated full-thickness skin graft taken from the chest-wall. The hand was placed on a wire splint with the fingers in flexion, and xeroform ointment-marine sponge dressing applied. The photographs indicate the appearance of the graft on the eleventh post-operative day when the first dressing was done. There is visible a small area in the centre of the graft which indicated a spot of necrosis. The remainder of the graft "took" without incident. The hand was subsequently placed in a reversed banjo splint in order to apply elastic traction to the fingers. At the time of discharge from the hospital there had been marked improvement of function.

The graft is next placed in the wound bed, care being taken to fit it in according to pattern. Because such care has been exercised in obtaining

hæmostasis, perforation of the graft is often unnecessary. In two instances, scars developed at the sites of perforation. However, should the surgeon be unable to obtain complete hæmostasis, perforation would be indicated in order to prevent the formation of blood-clots beneath the graft. The latter complication is one of the most common causes of necrosis.

Using fine horsehair on fine skin needles, the surgeon places a few sutures at cardinal points to anchor the graft in place. The remaining edges are approximated with a continuous stitch of horsehair. Accurate apposition of the skin edges is important. It makes for a neater scar and additional source of blood supply during the first eight or ten days. The entire surface is then covered with three thicknesses of gauze impregnated in 2 or 3 per cent. xeroform ointment. Blair recommends the use of this medication because it is supposed to be antagonistic to staphylococci which are present in skin and skin grafts. This is covered with several thicknesses of smooth gauze. Over this is placed a large moistened rubber bath sponge. A sterile bandage is then firmly applied. Considerable skill is required in applying the proper amount of pressure. If the pressure is too great, ischæmia and death of the graft will result. If the pressure is insufficient, blood-clots may form, jeopardizing the graft. On numerous occasions, I have used the marine sponge, as recommended by Blair. However, the results in these cases were not nearly as satisfactory as with the rubber sponge. Perhaps the reason for this difference is the fact that the rubber sponge possesses greater elastic resiliency and maintains this quality for a longer period post-operatively than the sea sponge. This difference has become so evident that I have given up the use of the sea sponge. It is important, when using the rubber sponge, not to apply a very voluminous dressing for fear of making the grafted region air-tight. If air is excluded, maceration of the graft may take place.

Absolute fixation of the grafted area during the period of healing is most desirable, especially in extremity surgery. Extended use of splints which immobilize contiguous joints greatly increases the likelihood of a perfect "take." In covering defects on the hand and fingers, fixation is best obtained by the use of splints made specially for each individual case. These are easily cut out according to pattern from rigid sheet aluminum. They are sterilized and applied at the operating table. They should be worn for at least three weeks.

The resulting wound following excision of the skin graft may be closed by undermining the edges and approximating them with silkworm-gut sutures. If tension is present, necrosis of the edges may be avoided by making numerous small releasing incisions in the skin surrounding the sutured wound. This procedure has proven most valuable. If the defect is a large one, it may be partially closed and the remainder is then covered with Thiersch grafts.

If the surgeon is satisfied with the asepsis of the operation, the control of bleeding and the fixation of the grafted area, he need not disturb the

dressing for two to two and a half weeks. There is no great harm in looking at the graft on the eighth or ninth day provided the pressure bandage is replaced in the same manner as at the original dressing. If the pressure dressing is removed too early, blisters form on the surface of the graft and these are prone to infection. The latter complication predisposes to ulceration of the graft. I have found it inadvisable to remove the tops of these blebs for this reason. Should infection develop, boric acid wet dressings are used. The pressure bandage should be maintained for a period of about three weeks, while the immobilizing splint is discarded after the third or fourth week. The grafted area should be protected from possible mechanical or thermal injury for about six weeks.

It is interesting to follow the return of sensation in these grafts. Apparently, the cutaneous nerve supply is derived from the surrounding skin, the direction of growth being in a centrifugal manner. A zone of hyperæsthesia of the skin immediately adjacent to the graft is noted for some time. Tactile sensation returns first and spreads from the periphery of the graft to the center. It is first noted about the sixth week. Pain sensation returns next, to be followed by temperature sense. In large grafts, complete return of sensation may not be elicited before a year or more after the operation. After six months, sensation in the small and medium-sized grafts is the same as that of the surrounding skin.

CONCLUSIONS

(1) The full-thickness skin graft has a fairly wide field of applicability. It should be reserved to cover fresh surgical defects and should not be used for granulating wounds.

(2) The pedicled skin flap should be used when the local condition requires more underlying tissue than a full-thickness graft can supply.

(3) There are numerous features in the use of this type of graft which the surgeon must recognize. These include the great probability of necrosis if placed over bare bone or tendon, future shrinkage, changes in color, the development of heavy scars at the edges, and the growth of hair.

(4) The technic of the operation is a most exacting one. The essential details include complete excision of scar tissue, rigid asepsis, complete hæmostasis, an operative technic which strives to eliminate any form of trauma to the graft, the application of firm, even pressure over the grafted area, and complete fixation of the part by the use of appropriate splints.

(5) Careful attention to the details of the post-operative care increases the chances of a successful "take."

(6) Finally, attention is again called to this most valuable type of skin transplantation, which merits more extended use than is now accorded it by the surgical profession at large.

TRANSACTIONS

OF THE

NEW YORK SURGICAL SOCIETY

STATED MEETING HELD APRIL 27, 1932

The President, DR. JOHN DOUGLAS, in the Chair

FRACTURE OF THE SURGICAL NECK OF THE HUMERUS

DR. RALPH COLP presented a woman, forty years of age, admitted to the Beekman Street Hospital, November 7, 1930.

On the day of admission, the patient, an obese woman of forty years, slipped and fell down ten steps, striking her right arm against a wall. Following the accident, she was unable to move her right arm and experienced excruciating pain around the region of the shoulder. When brought to the hospital, crepitus and a false point of motion of the upper extremity of the right humerus in the region of the surgical neck were elicited.

X-ray revealed a fracture through the surgical neck with considerable over-riding. (Fig. 1.) The arm was immediately put up in traction with ten pounds of weight. Check-up examination three days later revealed the head markedly rotated so that it was necessary to change the axis of the shaft a good 30° above a right angle. The direction of the pull was changed to correspond with this and twenty-five pounds were applied for four hours.

The following day, the check-up X-ray was still unsatisfactory and direction of the pull was changed to one of extreme abduction with fifteen pounds. This resulted in no change. One week after admission, an attempt was made under anaesthesia to reduce the fracture with fluoroscopical control, but no change could be made in the position of the fragments. November 26 an open operation under general anaesthesia was done. Incision between the deltoid and the pectoralis revealed the upper fragment, which consisted of the head and small part of the neck, rotated upward, forward and outward. The distal fragment was drawn up and pulled alongside of it so that it was lateral in position. No callus was visible. The fragments were reduced by manipulation and jammed one into the other and a three-inch ten-penny nail was driven from the distal fragment into the proximal one firmly utilizing the two. The arm was placed in abduction and external rotation, and a plaster spica was applied. Check-up X-ray after operation showed excellent position. (Fig. 2.)

Forty-six days after operation, X-ray showed callus about the fracture. No evidence of reaction about the nail. The plaster was then removed; firm clinical union was present. The arm was put up in traction and suspension for four days. Ten days later, she complained of discomfort in the right hand with swelling of the entire extremity and limitation of the flexion of the fingers. The condition suggested an acute arthritic process. Active abduction of the arm was limited to 45° , external rotation was restricted and internal rotation limited to 50° . Two weeks later, however, the swelling had subsided, and although there was some limitation of motion at the shoulder, the patient was discharged. When last seen, April 15, 1932, about one year

DIVISION OF FACIAL NERVE AT STYLOMASTOID FORAMEN

and seventeen months after operation, motion was practically normal in all directions and there were no complaints.

DR. CLAY RAY MURRAY remarked that fractures of the surgical end of the humerus which fail to reduce readily by traction can be easily attacked by open reduction if proper equipment and facilities are at hand. Where such facilities are not at hand, or where the patient's condition renders operation dangerous, the use of the Kirschner pin through the lower humerus with balanced traction exerted directly upward (toward the ceiling) with the patient supine, will often give excellent reduction of extreme deformity,



FIG. 1.—(Case I.) Fracture of the surgical neck of the humerus taken before operation.



FIG. 2.—(Case I.) Fracture of the surgical neck of the humerus taken seventeen months after operation.

where skin traction, or any traction in abduction or at the side, will fail. In late cases where open reduction is attended by considerable violence, if manipulative reduction, after freeing of the fragments from the soft parts, is attempted, the pin traction will often accomplish the reduction of the freed fragments with remarkable ease and, of course, without the additional trauma of manipulation. Doctor Murray cited a case in which the shaft of the humerus punctured the deltoid muscle in which the Kirschner wire put through the humerus facilitated reduction after the open procedure.

DIVISION OF FACIAL NERVE AT STYLOMASTOID FORAMEN

DR. RALPH COLP presented a Negro woman, thirty-eight years of age, who was admitted to the Beekman Street Hospital May 12, 1931.

During an altercation with another woman, she had been stabbed with a paring knife behind the left ear. Immediately she felt her mouth twist and could only open one side of the mouth. She never had any paralysis of the face before. She was immediately brought to the hospital. She was a well-developed colored female with a wound of the left mastoid region extending to the left auricle for about an inch. There was a complete peripheral left facial paralysis. (Fig. 3.)

A suture of the facial nerve was done eight days after admission, May 20, 1931. With a curved mastoid incision the distal end of the facial nerve was found, isolated and traced towards the region of the stylomastoid foramen. About one-quarter inch from the stylomastoid foramen, which was identified



FIG. 3.—(Case II.) Facial paralysis of the peripheral region due to division of the nerve of the stylomastoid foramen.



FIG. 4.—(Case II.) Photograph taken six months after operation showing restoration of facial musculature following suture of facial nerve of stylomastoid foramen.

by a probe, the nerve was found to be completely severed. In order to visualize the proximal end of the nerve, a portion of the mastoid was removed and about one-quarter of an inch of the external wall of the Fallopian tube. The nerve ends were then approximated without tension and were sutured with perineural sutures of Carrel silk, three in number. In order to adequately cover the nerve which was exposed in the Fallopian canal, a free fat transplant about two inches in diameter was taken from the anterior abdominal wall and placed in the cavity. The skin was sutured over this.

Six days after operation physiotherapy was started, consisting of radiant light to the left face for one week, one hour daily. The wound was clean and the sutures removed on the ninth day, and the patient was discharged June 9, 1931, to the physiotherapy department for treatment. She reported there for a week and was then lost sight of until October 30, 1931. Examination then disclosed definite improvement in all the movements of the left facial musculature. The droop at the corner of the mouth was not quite so

KRUKENBERG AMPUTATION

marked and she was able to close her left eye quite well. She was seen November 17, 1931, by Doctor Blakeslee, the neurologist, who felt that she almost had complete return of power and that further physiotherapy was unnecessary. (Fig. 4.)

DR. BYRON STOOKEY said that it seldom fell to the lot of the nerve surgeon to do an immediate end-to-end repair of the facial nerve since repair is usually done by the general surgeon operating for a parotid tumor. While Doctor Colp has done an end-to-end suture with excellent results, it is interesting to note that in spite of end-to-end suture the ability to wrinkle the forehead has not returned, whereas contraction of the lower half of the facial innervation has returned.

There is also a loss of spontaneous emotional control of the face in spite of the return of innervation of the lower half of the facial musculature. Volitional contraction of the frontalis and emotional control of the facial muscles are precisely the two factors which are likely to be lost after nerve crossing either facial-spinal accessory or facial-hypoglossal. The absence of these two factors is to be expected after nerve crossing but not after direct nerve suture, since after nerve crossing new and different nuclear centres with different reflex afferent and efferent connections are connected with the peripheral structures, and thus old reflex connections are lost, whereas by direct nerve suture the old nuclear connections are made and old reflex connections reestablished.

KRUKENBERG AMPUTATION

DR. RALPH COLP presented a boy, twelve years of age, who was admitted to the Beekman Street Hospital October 27, 1930.

On the day of admission, he had held an ignited torpedo in his hand which exploded. He was immediately brought to the hospital. Examination disclosed a maceration and avulsion of the entire right hand up to and including the wrist-joint, so that no bones were spared in the destruction. There were also powder wounds which extended through the skin into the soft parts over the lateral aspect of the arm on the same side to the mid-brachial region. Amputation of the right hand and wrist was done through the carpo-radial articulation. The periosteum of the radius and ulna was not disturbed. The skin was trimmed for a considerable distance and the parts remaining looked very clean. The whole area was thoroughly irrigated with saline and a few chromic sutures approximated the muscle and fascial elements over the ends of the bone, the skin being closed with a few silk sutures. At the same time, a débridement was also done on the powder marks of the arm. Two pieces of iodoform gauze were inserted into the defects of the arm and the wound dressed dry.

There was considerable sloughing following the procedure, but under Dakinization the stump was clean enough for a Thiersch graft on November 21, 1930. This was subsequently supplemented by pinch grafts. The forearm was ready for a Krukenberg plastic January 21, 1931. A brief résumé of the technic is herewith given:

(1) A U-shaped incision is made from the volar to the dorsal aspect of the forearm slightly to the ulna side, and over the attachment of the interosseous ligament to the ulna.

(2) The dorsal incision is deepened to the extensor muscles. The extensor communis digitorum is identified and the tendons to the second and third finger are sutured together. The tendons to the fourth and fifth fingers are similarly sutured. The extensor carpi ulnaris is left on the ulnar side. The brachio radialis and both extensor carpi radialis muscles are attached to the radius. The abductor pollicis longus, the extensor pollicis longus and brevis are excised.

(3) The volar incision is now deepened to the flexor muscles. The flexor carpi ulnaris and radialis are left on their respective sides. The divisions of flexor sublimis digitorum are treated similar to the extensor communis digitorum. The flexor profundus digitorum and the flexor longus pollicis are extirpated.



FIG. 5.—(Case III.) Showing grasping power with Krukenberg stump.

(4) The median and ulnar nerves are identified and adequately resected and the stumps injected with alcohol.

(5) The interosseous membrane is then slit *throughout* its length and removed so that the radius and ulna are then separated for about twelve centimetres of their extent, and the distal extremity of the ulnar and radius excised.

(6) The flexor and extensor tendons are then sutured together over the radius and ulna respectively.

(7) The radial stump as a rule may be covered with the overlying skin which is present.

(8) It is very seldom, however, that there is sufficient integument to cover the ulna stump. It is usually advisable to do a pedicle skin graft to this stump from the side of the abdomen. This is best performed by making a skin flap and suturing it to the skin left on the ulna. The stump is immo-

KRUKENBERG AMPUTATION

bilized to the abdominal wall for ten to twelve days. The skin flap is then freed from the abdomen and the closure completed.

January 28, 1931, the wound was dressed. The skin flap around the stump of the radius had sloughed while the pedicle flap to the ulna was viable.

February 11, under general anæsthesia, the pedicle to the graft was divided and sutured about the ulna, although part of it remained uncovered.

February 25, under anæsthesia, pinch grafts were taken from the right anterior femoral region and placed on the granulating area over the radius and parts of the ulna and paresine dressing applied.

March 4, 1931, the boy had amazing grasping power of the stump. (Fig. 5.) The ulna was practically healed and about 30 per cent. of the pinch grafts of the radius had taken.

The patient was discharged March 11, 1931, at which time the stumps



FIG. 6.—(Case III.) Showing case of Krukenberg operation of radial stump in pronation.

had practically healed. There was complete extension at the elbow (Fig. 6) and the patient had good grasping power of the stumps. Since that time, patient has been seen on many occasions. He has complete flexion and extension of the elbow; pronation and supination of the radius about the ulna is complete, although abduction and adduction of the radial stump is practically negligible.

This case demonstrates a simple method first described by Krukenberg in 1917 of converting a forearm without a hand into a grasping sensitive mobile extremity. It is certainly superior to any artificial hand or a complicated kinoplastic amputation.

There is no doubt that the cosmetic effect is poor but an artificial hand may be fitted which may prove useful because of the mobility of the hand transmitted through the mobile radial stump, or a special working prosthesis may be worn which will permit the individual to actually perform heavy manual labor.

SUBSTERNAL GOITRE WITH ACUTE DYSPNOEA. BRONCHOSCOPY AND SUBTOTAL THYROIDECTOMY

DR. RALPH COLP presented a woman, forty-five years of age, from the surgical service of Dr. Richard Lewisohn at Mount Sinai Hospital. Past history was irrelevant and there were no symptoms of preëxisting goitre, either simple or toxic.

For the past year, the patient had been aware of an increasing fullness at the base of the neck, but she was never aware of a definite mass in this location. In the week prior to admission, she had three attacks of marked dyspnoea, cyanosis and loss of consciousness. The first attack occurred four days ago, the second, two, and the third on the day of admission. Each episode started with a choking sensation and dyspnoea. The inspiration and expiration became stridulous in character, and increasingly difficult. Each attack lasted for an hour and finally terminated with the expectoration of phlegm.

She was an obese, short, middle-aged woman sitting upright in bed, extremely dyspnoeic, with marked inspiratory stridor. She was cyanotic. The pulse was 90, respirations 30, and temperature 99.8°. Examination disclosed a hard, firm, diffuse enlargement of the thyroid, slightly more marked on the left, extending suprasternally about two inches. This mass disappeared sub-sternally. X-ray examination of the chest showed a marked enlargement of the thyroid gland which extended into the chest about two centimetres below the aortic arch. The intrathoracic portion of the trachea was displaced to the right. There was a hypertrophy of the left ventricle with some dilatation.

In view of the impending asphyxia caused by the compression and a deviation of the trachea, operation was performed immediately. A seven-millimetre bronchoscope was passed under local anæsthesia of cocaine. At about twenty-five centimetres the trachea was compressed to three millimetres. The stridor immediately disappeared with the dilatation of the trachea and the cyanosis cleared as soon as the oxygen was administered through the tube. Under novocaine anæsthesia, a transverse Kocher incision was made suprasternally. The ribbon muscles were divided transversely. The upper pole of the right lobe of the thyroid was ligated and divided, and by traction and digital manipulation, the substernal portion of the right lobe was delivered. The lobe was excised in its major portion together with the isthmus. The same procedure was performed on the intrathoracic left lobe. The pathology of the gland was a colloid goitre with fibrous and chronic inflammation. The trachea was now completely exposed and the bronchoscope was withdrawn. There was no subsequent collapse of the trachea and there was no recurrence of the dyspnoea. The ribbon muscles were reunited by mattress sutures. The substernal space was packed with iodoform gauze and the wound was closed with pincets. Following this operation, she did well, although she developed a small patch of bronchopneumonia in the left lower lobe. She was discharged on the tenth post-operative day.

The passage of a bronchoscope in the intrathoracic type of goitre with tracheal compression and deviation certainly relieves the dyspnoea and simplifies the operative procedure. A definite air way is maintained, the danger of immediate tracheal collapse is obviated and the trachea can be identified in the operative field without difficulty by the presence of the metal cylinder. The bronchoscope is preferable to a whale-bone catheter in that the metal tube is passed under direct vision, the tracheal air way can be kept free from mucus by suction, and oxygen can be administered, if necessary. This patient was not particularly uncomfortable with the bronchoscope in place during

the operative manipulation. At the conclusion of the thyroidectomy, the tube was slowly withdrawn and the calibre of the trachea observed. If a collapse would have occurred, tracheotomy could have been performed immediately. This, however, was not necessary.

DECOMPRESSIVE LAMINECTOMY FOR FRACTURE OF THE SIXTH CERVICAL VERTEBRA WITH ALMOST COMPLETE QUADRIPLÉGIA

DR. DEWITT STETTEN presented a man, aged thirty-five years, who was admitted to the Lenox Hill Hospital December 22, 1931, with the history that on the previous afternoon he had been struck on the back of the neck by some blunt object, possibly a blackjack. He became unconscious, and, on regaining consciousness, could move neither his arms nor his legs; his legs were numb, he had pain in the back of his neck, and he was unable to urinate. He was a fairly well-nourished and well-developed individual. There was some ecchymosis of the left lower eyelid and of the left malar region. There was some spasm and rigidity of the posterior cervical muscles, and in the region corresponding to the sixth cervical vertebra there was definite bony crepitation on manipulation of the sixth spinous process. There were no excursions of the chest-wall, respirations being entirely diaphragmatic. There existed almost a complete flaccid paralysis of all the extensors of both upper extremities, of the muscles of both hands, and of both lower extremities, with spastic contraction of the flexors of the forearms and hands, the patient holding both forearms flexed on the chest in the characteristic Erb position. The spasticity of the flexors of the upper extremities was perhaps a little more marked on the right than on the left side. He could move both great toes slightly, particularly the left, which he could extend and flex a trifle. The right could only be feebly flexed. The abdominal and right cremasteric reflexes were absent; the left cremasteric was very sluggish. The biceps, triceps, patellar, suprapatellar and Achilles reflexes were all equal and active. There was no Babinski or Oppenheim, but on irritating the soles the patient exhibited marked mass reflex or spinal automatism with gross muscular contractions of both upper and lower extremities. There was moderate anæsthesia to pain, tactile and temperature sense on the inner aspects of the hands, forearms and arms, and from a hand's breadth above the level of the nipple downward. The sense of position in the lower extremities was also disturbed. There was no dissociation of sensation. The neurological picture definitely indicated an involvement of the lower cervical (C VII, C VIII) and upper thoracic (D I) segments of the cord. Bedside X-ray examination revealed no recognizable fracture or dislocation in the cervical spine. The spinous process of the sixth cervical, however, was slightly out of alignment, being displaced a trifle to the right, and there was a definite torticollis with the head turned to the left, and some elevation of the left shoulder. Rectal examination showed marked relaxation of the sphincter ani.

Before admission to the hospital, he had been catheterized, and, apparently, the urethra and bladder had been infected, because a definite purulent urethral discharge was noted immediately on admission. It was decided to continue catheterization with the usual disinfection of the bladder, and not to attempt emptying the bladder by expression. There was complete rectal incontinence. Two days after admission the feeble great toe movements on both sides disappeared. The Queckenstedt manoeuvre showed no spinal block. The spinal fluid was clear and showed twenty-five lymphocytes to the cubic millimetre.

Five days after admission the patient had apparently deteriorated as indicated by lost toe movements. The outlook for the conservative treatment was very grave. December 28, 1931, operation was performed by Doctor

Stetten under local anæsthesia with the patient in the prone position. A long, longitudinal, median incision over the lower cervical and upper thoracic spine was made. As soon as the spines were exposed, distinctly greater mobility of the spinous process of the sixth cervical vertebra and definite crepitation on motion were noted. There was an irregular oblique line of fracture through both laminae of the sixth cervical vertebra, on the right side about $1\frac{1}{2}$ centimetres from the spine, and on the left side about $1\frac{1}{4}$ centimetres from the spine. The lines of fracture ran from above downward and from within outward. There was a definite, though slight, depression of the fractured

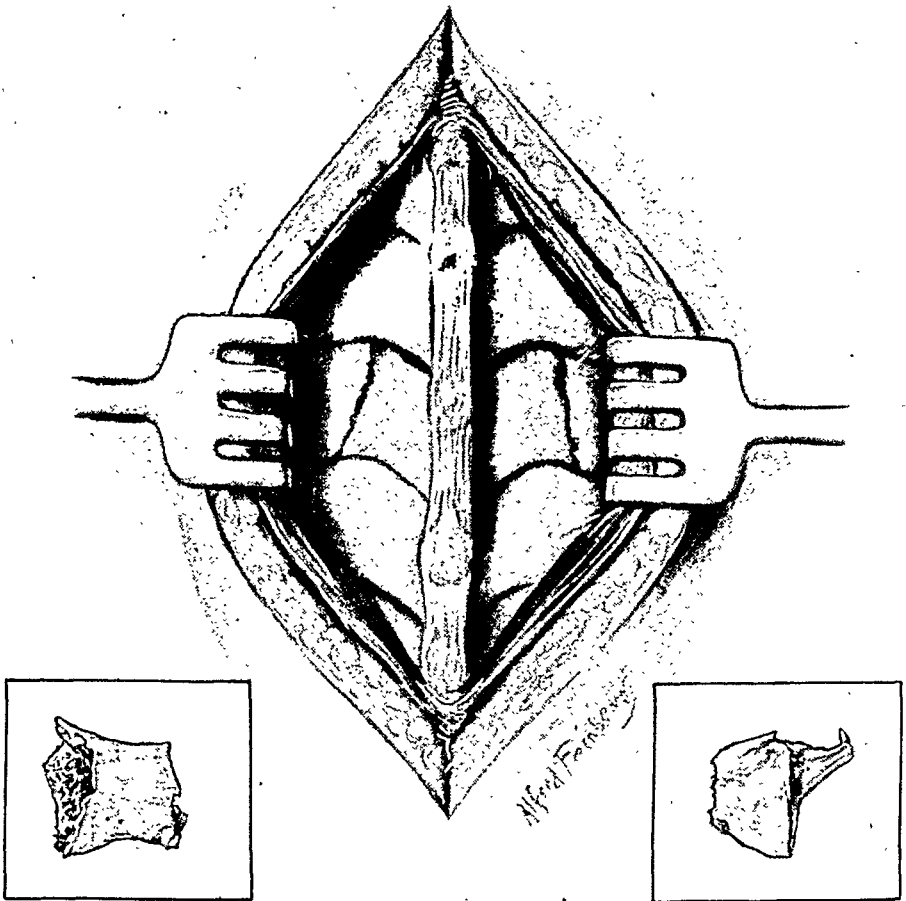


FIG. 7.—Drawing showing lines of fracture in both laminae of the sixth cervical vertebra and slight depression of the laminar arch as found at operation. Inserts show the appearance of the fragments of the laminae when removed. Note curved spicule on upper edge of the fractured end of the right fragment.

arch and some extravasation of blood around the fracture lines. The spinous processes and arches of the fifth and seventh cervical vertebrae were thoroughly exposed and found to be uninjured. After removing the spinous process of the sixth cervical vertebra with the rongeur, the loose fragments of both laminae were extracted without difficulty, first from the right and then from the left side. At the upper edge of the fractured end of the right fragment was a definite, curved spicule of bone about three-quarters of a centimetre long, which apparently had further pressed on the cord. (Fig. 7.) The cord surrounded by its dura filled the canal rather tensely. The dura was oedematous and slightly ecchymotic. It was decided not to open the dura for fear of a herniation of the cord. The sharp lateral edges of the fractured

laminae were rounded off with a rongeur. A moderate amount of bleeding was encountered on doing this, especially on the right side, but this was easily controlled by two gauze tampons to the right lateral stump. These were led out through the central portion of the wound, which was sutured in the usual manner.

The patient made a satisfactory recovery from the operation, although two days later his temperature rose to 102.6° and his urine became more and more cloudy, in spite of bladder irrigations with boric-acid solution, and instillation of collene and urotropin internally. An indwelling catheter was inserted. Three days after operation there was noted for the first time a definite return of some power in the lower extremities. The patient was able to flex and extend the toes of the left foot, particularly the great toe, with visible muscular contractions of the leg. This rapidly increased and within another twenty-four hours some return of power was noted in the paralyzed muscles of the left hand, arm and forearm. Three days later there was beginning power noted in the right lower extremity. By January 9, 1932, sensation was rapidly recovering, and passive and active motion of the arms and legs, and massage, to which was subsequently added Faradism, were begun. Steady improvement in all four extremities continued with relaxation of the spasm of the right biceps. There was likewise improvement in the movements of the thoracic muscles in breathing. The wound had healed by primary union.

In spite of this, however, the patient did not seem to be progressing favorably. There was considerable loss of weight and marked atrophy of all the musculature, indicating medullary or anterior horn involvement. He had evening rises of temperature as high as 103° . The urine was very purulent and showed *Bacillus coli*, *Staphylococcus albus* and *Bacillus subtilis* on culture. There was no evidence of involvement of the kidney. As it was apparent that the infection of the lower urinary tract was threatening the patient's life in spite of the favorable progress of the spinal condition, it was decided, as a last resort, to drain the bladder suprapubically. January 22, 1932, a suprapubic cystostomy was done by Doctor Stetten in the usual manner, the Kader technic being used. Following this, bladder irrigations through the suprapubic drainage tube were instituted. By February 13, 1932, a definite improvement in the patient's general condition had begun. Motion in all the extremities was much better, and the chest movements on breathing were very good. Sensation had practically returned to normal.

February 23, 1932, the patient began to show fair control of the sphincter ani and rectal examination showed considerable tone of the muscle. Since February 25, 1932, his temperatures have remained normal. The suprapubic drainage tube was removed February 29, 1932, and the patient was allowed up in a chair. Within a few days he began to pass some urine through the urethra. The amounts of urine gradually increased, and by April 20, 1932, the suprapubic fistula was completely closed. The patient began definitely to gain weight, his last weight being only ten pounds below his normal weight before the accident. His atrophied muscles also gained in volume. March 28, 1932, he was walking with help and from April 13, 1932, he was walking without help but using a cane. Since April 16, 1932, he has been walking without a cane, although his gait has been somewhat spastic and uncertain but is improving from day to day. There is a definite drop-foot on the right side due to weakness in extension of the ankle. The extension in the right great toe has not yet recovered and the return of function of the right triceps

has been very sluggish, although the patient is now beginning to extend his forearm a little when it is held in a horizontal plane. The superficial reflexes have all recovered and all the deep reflexes are exaggerated with ankle and suprapatellar clonus. There is a left Babinski. The patient has acquired very fair control of his bladder, although there is some urgency, and he has good control of his rectum.

The case was presented with the realization that the operative treatment of this case is not quite in accord with the teaching of most neurologists and neuro-surgeons in this country. The fact is that here was a case that was definitely deteriorating, where an extremely grave prognosis was given by all the neurologists who examined him, and where, as a forlorn hope, operative intervention was finally decided upon, and followed by almost immediate improvement. It is believed that in this case there was a spinal concussion with an œdema and possibly a hæmorrhage of the spinal cord, and that there existed a definite compression of the swollen cord by the slightly depressed laminar arch, added to by the spicule of bone from the right lamina. The removal of the arch, even without opening the dura, relieved the pressure and permitted an absorption of the œdema and the possible hæmorrhage. Foerster, of Breslau, advocates operation in all of these cases as soon as the spinal shock has subsided. As a matter of fact, there is really no alternative. The operation is an extremely simple procedure, without any element of seriousness, and can easily be performed under local anæsthesia. Another feature worthy of attention is the apparent value of the suprapubic drainage of the infected bladder, which, in this case, threatened to nullify the success of the laminectomy. If the bladder is already infected before the Credé method of emptying it can be instituted, a suprapubic cystostomy may prove a life-saving procedure, as it seems to have done in this case.

DR. BYRON STOOKEY said that the essential problem in fracture dislocation of the cervical vertebræ is reduction of the displacement with relief of the pressure of the displaced vertebræ upon the spinal cord. It was his opinion that by far the most satisfactory procedure is reduction by traction and application of suitable measures to maintain the reduction rather than by open operation and immediate fusion of the vertebræ.

With forward displacement of the bodies of the vertebræ reduction of the vertebral displacement by operation seldom can be accomplished. By laminectomy the arches of the vertebræ are removed and the stability of the bony structure weakened without reduction of the displaced bodies. In early cases traction without operation usually permits satisfactory reduction of the displaced vertebræ and relief of pressure upon the spinal cord can usually be accomplished. In late cases reduction by traction frequently cannot be done.

Neither by traction nor by operation can the damage already done to the spinal cord by hæmorrhage within the spinal cord be altered. However, by reduction of the displaced vertebræ and the coincident realignment of the spinal cord into its normal position within the vertebral canal, the cord is placed in a more favorable position than when the vertebral displacement is not reduced and only a decompressive laminectomy is done. In the latter instance the dorsal alignment of the vertebral canal is straightened; the ventral angulation remains and the sharp edge of the displaced vertebræ persists, whereas by traction and reduction without operation the contour of the dorsal

and ventral parts of the vertebral canal can usually be restored if traction can be made early.

This patient apparently had a simple fracture of the lamina without displacement of the vertebral bodies with comparatively little or no compression of the cord. The manometric test of the spinal cord shows no block and the fluid was clear, which is excellent evidence of the freedom of the spinal subarachnoid space from serious pressure.

One gathers that the greatest disturbance was the hæmorrhage into the spinal cord with resulting cord signs and spasticity. This hæmorrhage into the cord was the result of the blow and not due to prolonged pressure on the cord. Simple fracture of the lamina which no doubt existed could have been corrected, in Doctor Stookey's opinion, by simple traction and immobilizations. Laminectomy did not alter the situation as far as the hæmorrhage within the cord is concerned and Doctor Stetten very wisely did not open the dura of the spinal cord in view of the signs which he already had found.

Hematomyelia usually shows recession and consequent improvement in the signs, which, of course, laminectomy does not alter. Doctor Stookey's opinion was that as a rule traction is far superior to laminectomy and that in this instance simple traction and immobilization were preferable to operation.

DR. CLAY RAY MURRAY emphasized the amount of relief secured by traction in extension of the spine in these cases. He thought that in the presence of direct bony pressure on the cord, or even when the symptoms were due to hæmorrhage and œdema, under proper traction and extension those symptoms would clear up in the vast majority of cases with as much efficacy as operation could offer, without any of the risks of operation. Laminectomy in his opinion does not present the chances of recovery which may be present under more conservative types of treatment. He reserves it for those cases which under hourly observation either fail to show any relief under traction-extension of the spine, or actually retrogress, and for those cases in which improvement occurs for a while but then ceases short of a point representing a satisfactory cord function.

DOCTOR STETTEN reported that the spinal fluid was not bloody, and there was no evidence of block. In spite of these facts, however, Dr. Foster Kennedy strongly urged him to operate on this man, because Doctor Kennedy felt that otherwise the prognosis was utterly hopeless. Doctor Stetten realized that surgical intervention in these cases is not looked upon with great favor in this country, but felt that the successful result in this case was worth reporting. He also appreciated that one cannot say that this patient would not have recovered without operation, but the fact remains that he made an unusual recovery after operation, and it is possible he may not have done so without.

CHRONIC SUPPURATIVE PERINEPHRITIS

DR. DEWITT STETTEN presented a girl, aged fifteen years, who was admitted to the Children's Division of the Lenox Hill Hospital November 30, 1931, under the care of Dr. Jerome S. Leopold. For two and one-half years the patient had been complaining of obscure right-sided abdominal pain, had become progressively weaker, had not grown nor matured normally, and had developed a gradually increasing pallor. Recently she had acquired a limp with favoring of the right leg, and about two years previously a rather marked scoliosis to the left had formed. About three years before admission she had had several large furuncles on the right buttock. A few months later, on June 29, 1929, she was admitted to the Fifth Avenue Hospital, complaining of pain in the right upper quadrant of about ten days' duration. A diagnosis of a laterocecal appendix with abscess or a perinephritic abscess was made and the patient was operated on July 5, 1929. An appendectomy was done through a right Kammerer incision. An inflamed laterocecal appendix was found but no pus. The kidney region was carefully examined but there was no evidence of a perinephritic abscess, although there was some inflammatory oedema of the peritoneum over the lower portion of the kidney.

The patient's convalescence was rather stormy and for some time after operation she suffered from indefinite abdominal pains. She did not improve but continued to lose weight and began to limp, favoring the right leg. On admission to the Lenox Hill Hospital she presented the picture of an underdeveloped, emaciated child with drawn facies and marked pallor. She had a pronounced dorsolumbar scoliosis with lumbar convexity to the left. There appeared to be some spasm over the right lumbar region, but no bulging, tenderness or fluctuation. Murphy's sign was negative. The abdomen was scaphoid. In the right upper quadrant could be felt a definite firm, fixed mass, corresponding to the lower right kidney region which was slightly tender on deep pressure. In the left upper quadrant could be felt a smooth, firm mass, which moved on respiration to below the umbilicus, and which was undoubtedly a large kidney. X-ray examination showed a marked left lumbar scoliosis, almost complete obliteration of the right psoas margin, a very large left kidney, and no definite right kidney shadow. Skiodan injection revealed normal function and outlines, left, and much impaired function, right. On cystoscopy the bladder was normal and catheters could be passed up both ureters. The indigo-carmin test showed marked loss of function of the right kidney and a pyelogram, right, showed distinct clubbing deformity of the calices.

The temperature during the period of observation from November 30 to December 21, 1931, fluctuated irregularly between 98.2° and 102.8°. The blood showed a severe secondary anæmia with a moderate leucocytosis. Blood and urine cultures were sterile. The urine was practically normal. The von Pirquet test was negative.

After a preliminary transfusion she was operated on by Doctor Stetten under general anæsthesia December 21, 1931. Through an oblique right lumbar incision, the perirenal space was entered and found to be a mass of dense, infiltrated, oedematous fat, in which were areas of yellowish, cheesy, necrotic, semi-solid material, obviously old inspissated pus, and in places a franker, fresher, and more fluid purulent exudate. This was particularly marked around the upper pole of the kidney. A culture was taken and the infiltrated perirenal tissue was incised down to and through the thickened kidney capsule, and the kidney was decapsulated. The kidney itself was

relatively normal. The culture of the pus showed a pure *Staphylococcus aureus*. The patient's convalescence was relatively uneventful. She was afebrile on the fourth day after operation and steadily improved from that time on. Drainage was maintained as long as possible. Her blood-picture assisted by several transfusions rapidly improved and she steadily gained weight and strength. Her limp and scoliosis gradually disappeared. She was discharged from the hospital February 14, 1932, with the wound entirely closed. March 17, 1932, she menstruated for the first time. Her weight at the present time is 107 pounds, a gain of thirty-nine pounds since just before her operation, and her blood-picture is practically normal.

DR. DONALD GORDON said that in the presentation of this case he was the surgeon who operated upon the patient for appendicitis at the Fifth Avenue Hospital.

At operation, the mesocolon had to be incised to release the appendix. A degree of oedema was appreciable at the lower pole of the kidney. The peritoneum was opened to a small extent, and the lower pole of the kidney palpated without revealing sufficient pathology to warrant further exploration for pus, in view of the position and appearance of the appendix. After three months the patient had gained nine pounds, but subsequently in a two-year follow-up period, made no progress; but there was no mention of a limp being present, though she unquestionably was not a well child. The persistence of symptoms in the hospital and after discharge were never explained until Doctor Stetten's information about the case.

DR. ABRAHAM HYMAN called attention to the long period of time, two years, which elapsed before the kidney condition was recognized. This was longer than usual although there have been a number of cases where one to one and one-half years have elapsed before diagnosis was made. Even in the late stages of the condition the diagnosis has been frequently overlooked or mistaken for gall-bladder or appendicular disease. This is due chiefly to their being so few symptoms referable to the kidney. The course is likely to be afebrile, although there may be a low-grade temperature. Urinary examination may be entirely negative and cystoscopy throw no light on the situation. The most important diagnostic findings are the radiographical signs; these in a large percentage of cases enable one to differentiate the condition. The typical radiographical changes are enlargement of the renal shadow, obliteration or haziness of the outline of the psoas muscle, and a scoliosis of the spine with concavity towards the affected side. In addition, there are almost always suggestive pyelographical changes, evidenced by distortion or filling defects of the pelvis or calices. In the early cases all of these signs may be ill-defined, not being suggestive enough to establish a diagnosis. In such conditions, at the suggestion of Doctor Beer, at Mount Sinai Hospital, they activate the focus by the injection of staphylococcus vaccines, and have by this process been enabled in a few instances to locate the lesion. Following injections of the vaccine, where the temperature has previously been normal or at a low level, a positive reaction is evidenced by a

rise of temperature with pain and tenderness to percussion in the affected kidney. Practically all of these cases do well with a simple decapsulation and drainage. In only a few instances has it been found necessary to do a secondary nephrectomy.

SPLENECTOMY FOR CHRONIC THROMBOCYTOPENIC PURPURA

DR. DEWITT STETTEN presented a woman, aged forty-five years, who gave a history of profuse menstrual periods of a twenty-eight-day type, lasting six or seven days, and dating from the onset of her menses at the age of twelve years. About eight years before admission she had had a period which lasted ten days and was unusually profuse, assuming the character of a real hæmorrhage. Five years later she had a similar episode. About six weeks before admission she had a menstrual period with very severe bleeding which lasted ten days. The bleeding stopped, but recurred with her present period about four days before admission, when she again bled very profusely and continuously. This profuse bleeding persisted and she developed profound general weakness, marked pallor, and dizziness. The patient had never been pregnant, and there had been no uterine bleeding between her menstrual periods. She had had occasional epistaxis and bleeding from the gums. Ever since childhood she would easily develop purpuric spots after slight injury. She had never had any intestinal bleeding. She weighed 125 pounds. Her skin showed several scattered purpuric spots, and several small subconjunctival petechiæ on the lower eyelids. In both nares there were several dried blood-clots. In the mucous membrane of the mouth were several fresh petechiæ over the uvula and soft palate. The veins in the neck pulsated markedly, but there were no palpable lymph-nodes. There was a short blowing systolic murmur in the left second interspace. The liver edge was just palpable, and the spleen was enlarged to four fingers below the costal margin along the anterior axillary line. In the lower abdomen was a large, irregular, hard, nodular mass, obviously a fibromyomatous uterus, reaching from the symphysis to two inches above the umbilicus, and laterally three inches to each side of the mid-line. Vaginal examination showed the bulging of the posterior fornix due to an irregular, hard, nodular mass, which pushed the cervix up against the symphysis. This mass was continuous with the large fibromyomatous uterus, which was felt on abdominal palpation. It was firmly impacted in the pelvis. A transfusion of 600 cubic centimetres of blood was given December 6, 1930, followed by four deep X-ray treatments to the pelvis from December 10 to 13, 1930, inclusive. Following the X-ray treatments the bleeding diminished somewhat, but a careful hæmatological study by Dr. M. A. Weiss December 7, 1930, showed a very severe secondary anæmia, 3,410,000 erythrocytes with 47 per cent. hæmoglobin; a moderate leucopenia, 4,600 leucocytes with a normal differential count; a prolonged bleeding time of twenty-four minutes; a normal coagulation time of four minutes; delayed clot retraction; and marked reduction in the blood platelets to 10,500.

The diagnosis of thrombocytopenic purpura, probably of the reticulo-endothelial or thrombolytic type, was now rather clearly established, throwing somewhat into the background the importance of the uterine problem. The patient was treated for four weeks on the medical service of Dr. M. A. Rothschild at the Beth Israel Hospital. Her menstrual bleeding continued most of that time, and she also suffered from nose-bleed. Her platelets

SPLENECTOMY FOR CHRONIC THROMBOCYTOPENIC PURPURA

ranged from the initial count of 10,500 to 39,500, her anæmia remaining about the same, and her leucocyte count ranging from 4,400 to 9,600 with comparatively normal differential figures. She was finally transferred to Doctor Stetten's service and January 8, 1931, after a second transfusion of 500 cubic centimetres of blood, a splenectomy was done by him. The spleen was about twice its normal size, fairly firm and very elastic. There were fine adhesions between its outer surface and the vault of the diaphragm, but these were separated without difficulty, and the removal of the organ, after the usual ligation of the pedicle, was quite simple. The microscopical examination of the spleen was essentially negative.

Convalescence was relatively uneventful, and the wound healed by primary union. Immediately after operation the platelets jumped to 196,000, running up as high as 296,000. There was also a leucocytosis running up to 30,400 immediately after operation, and remaining around 10,000. The menstrual bleeding ceased immediately and did not recur. The patient's general condition also improved, her hæmoglobin going up to about 60 per cent. with 4,000,000 erythrocytes. About January 17, 1931, a rather marked dermatitis developed over the X-rayed area. The patient's progress was so satisfactory that February 14, 1931, under spinal anæsthesia, Doctor Stetten performed a supravaginal hysterectomy with double salpingo-oöphorectomy. A very large, irregular, nodular uterus, the size of a seven months' pregnancy, containing various sized and shaped subserous, intramural and submucous fibromyomata, was removed, with both tubes and ovaries. A partially obliterated appendix was also removed.

The patient made a very satisfactory recovery from this second operation, but around March 10, 1931, she developed some induration in the lower angle of the wound with a slight rise of temperature. This induration, probably a sequel of the X-radiation, formed into an abscess, which March 13, 1931, was opened and several ounces of thick, yellow, odorless pus were evacuated. From then on the patient's convalescence was quite satisfactory except that the abscess cavity healed very sluggishly. Since the wound has been healed, the patient has been steadily improving and is now in perfect health. Her weight now is 153 pounds, a gain of twenty-eight pounds since just before her splenectomy, and her blood shows a very interesting picture. She now has a marked polycythæmia with 7,090,000 erythrocytes, and 90 per cent. hæmoglobin, a definite leucocytosis of 17,800 with 50 per cent. polymorphonuclears, 39 per cent. lymphocytes, 8 per cent. monocytes, and 1 per cent. each of basophiles, metamyelocytes and premyelocytes. The platelets have remained at 295,000. What undoubtedly brought about a successful result in this case was the preliminary splenectomy.

DR. ALLEN O. WHIPPLE said that he had a similar case in the Presbyterian Hospital. The patient, a woman, was referred to the Thyroid Clinic because of a mass, increasing in size, in the left side of the neck, said to be an adenoma of the thyroid. Because of the possibility that the adenoma might continue to increase in size and give her cardiac symptoms, she came to the hospital for operation. In the course of questioning she gave a history of bruising easily and of occasional nose-bleeding. She had prolonged clotting and bleeding time and the platelets were reduced in number. An incision $\frac{1}{2}$ centimetre in length was made in the neck but bleeding continued for twenty-four hours and for that reason it was decided that splenectomy was

indicated. She went through this operation exceedingly well and is now convalescing.

DR. EDWIN BEER said that in regard to the excellent results supposed to follow splenectomy, he wished to refer to a case of thrombocytopenic purpura in which bleeding did not cease, following splenectomy, until the pituitary was exposed to deep X-ray therapy.



FIG. 8.—Radiograph of hand before first operation, showing various amputations.

PLASTIC RECONSTRUCTION OF HAND WITH PHALANGEALIZATION OF THUMB

DR. DEWITT STETTEN presented a man, aged nineteen years, who October 3, 1930, severely crushed his left hand. He was taken at once to the Bronx Hospital, where in spite of conservative treatment, the entire index finger, distal phalanx of the thumb, and second and third phalanges of the middle, ring and little fingers were lost, and the skin of the palm and dorsum was also completely destroyed, all through the development of gangrene. October

PLASTIC RECONSTRUCTION OF HAND

24, 1930, he was admitted to the Lenox Hill Hospital, under Doctor Stetten's care. At that time the left hand was completely devoid of skin from the wrist downward, and was covered by a fairly clean, rather flat, granulating surface. The index finger was missing. The thumb and middle fingers had been amputated through the middle of the proximal phalanges, and the ring and little fingers had been amputated through the distal fourths of the proximal phalanges. As there was no skin between the stumps of the thumb and the index metacarpal, and between the stumps of the middle, ring and little fingers, there was a tendency for the interdigital spaces to become obliterated. Wrist motion, both flexion and extension, was somewhat restricted, as was supination and pronation. X-ray examination (Fig. 8) simply confirmed the findings of the various amputations, which appeared to be fairly clean cut. No fractures nor disease in the remaining bones of the hand was revealed.

A plastic reconstruction of the hand was undertaken. Under appropriate dressings the granulations still further improved and some islands of epi-



FIG. 9A.—Photograph of hand before operation, palmar aspect.

FIG. 9B.—Photograph of hand before operation, dorsal aspect.

thelium formed, particularly over the thenar and hypothenar eminences of the palm. These islands gradually fused, covering these areas to a large extent. From the thenar eminences the epithelium extended around somewhat on the radial side. A small amount of the same kind of epithelium formed in the webbing between the thumb and head of the index metacarpal. The dorsum showed practically no epithelial islands. (Figs. 9A and 9B.)

The first operation was performed November 10, 1930. A pocket of skin was prepared on the right side of the chest on a level with and close to the nipple, the width of the flap being wide enough to cover the hand comfortably. The full thickness of skin was undermined and separated from the chest wall, leaving the flap attached by broad pedicles above and below. The islands of epithelium were removed from the radial side and from the webbing between the stump of the thumb and head of the index metacarpal, the epithelial patches on the palm being retained. The edge of the skin on the dorsal side of the wrist was freed for about a quarter of an inch upward and the edge it-

self freshened. A piece of rubber dam was laid into the floor of the pocket across the chest, completely covering same. The edges of this were drawn through anteriorly and posteriorly and sutured to the skin to hold it in place. The left hand was comfortably placed into this subcutaneous pocket and the skin on the anterior edge of the flap was sutured to the skin of the dorsum of the wrist. A dry dressing was applied, and the hand and arm were immobilized in a starch bandage.

The wound between the dorsum of the wrist and the anterior edge of the flap healed by primary union, and the flap itself promptly became adherent to the dorsum of the hand. December 4, 1930, the second stage was done. The upper pedicle was divided a moderate distance above the hand, but still well below the axillary hair. The pedicle was loosened from the chest wall and some of the thin epithelium from the thenar eminence was removed. The skin on the radial side of the anterior surface of the wrist was freed and the edges freshened. The flap was rolled around the thumb and the tips of the fingers, and sutured without tension to the hand, the suture line at the wrist being between the anterior edge of the flap and the relatively normal skin on the anterior surface at the radial side and at the thenar eminence between the upper edge of the flap and the new epithelium on the palm. Some pinch grafts were taken from the skin of the anterior surface of the chest and applied to the chest wound, and the anterior upper angle of this wound was partially sutured. The patient also made an uneventful convalescence from the second operation except that the pinch grafts, though they seemed to have taken at the first dressing, apparently absorbed later, and there was a slight retraction of the upper edge of the flap, but there was primary union of the suture between the anterior edge of the flap and the skin at the anterior surface of the radial side of the wrist.

January 17, 1931, the third stage of the operation was performed. Both anterior and posterior incisions of the flap were extended downward, and the flap was freely mobilized from the lower chest and lateral abdominal walls, with the pedicle still broadly attached below. The hand had grown rather firmly to the chest wall, especially at the stump of the little finger, and sharp dissection was required to separate it. The hand was lowered so that the flap rolled around on the palm and all the new epithelium on the palmar surface of the hand, which had formed over the thenar and hypothenar eminences, was removed with knife and curette. Most of the removed epithelium was grafted to the fresh wound area on the lower chest. All the skin edges of that portion of the flap that was adherent to the hand, and of the skin on the anterior surface of the wrist at the ulnar side, were freed and freshened. The free edge of the anterior portion of the flap was sutured to the skin of the anterior surface of the wrist, at the ulnar side, and to the edge of the adherent flap along the stump of the thumb. The posterior free edge of the flap was sutured to the edge of the adherent flap over the tips of the finger stumps and palmar surface of the stump of the middle finger, leaving only a very small area over the thenar eminence and adjacent palm uncovered. There was no tension on the sutures, and the entire enveloping flap seemed very well nourished. A slight flexion contracture of the wrist had developed as a result of the posture, which it was deemed inadvisable to disturb by forcible manipulation at that time. A dry dressing, with an effort to produce a little more extension at the wrist, and a starch bandage, were applied.

There was again a relatively uneventful convalescence with rather satisfactory union of practically all the sutured edges of the flap. Some of the transplanted epithelial grafts had taken in part. February 12, 1931, the fourth

PLASTIC RECONSTRUCTION OF HAND

stage of the plastic repair was done, the remaining pedicle of the flap was divided, leaving sufficient flap to cover almost the entire defect on the hand and the hand was separated from the chest wall. The skin edges on the radial side of the hand were freed, and the divided edge of the flap was sutured thereto. The granulations on the tip of the hand stump, on the ulnar side, were curetted and the adherent skin edge at this point freed and freshened, and sutured to the remaining posterior edge of the flap. After thoroughly removing the granulations on the wound of the chest wall right down to the scar tissue, a Thiersch skin-graft was done from the right thigh covering the entire area. Also after curetting the granulations, a small Thiersch skin-graft was made to a small uncovered area over the thenar eminence of the hand. There was a marked flexion contracture of the elbow and of the wrist due to the protracted immobilization. Under anæsthesia the elbow could be extended only with considerable force to about 110° , and the wrist to about 160° . No attempt was made to correct forcibly this contracture. Silver-foil dry dressing was applied to the grafted areas and a palmar splint applied to the hand in as great extension as possible without undue force.

The patient again made an uneventful convalescence, the flap remaining well nourished and the sutured portion healing by primary union. The Thiersch skin-graft on the thenar eminence took about 50 per cent., and even at the first dressing it was noticed that there was a marked degree of acute, almost normal sensation in practically the entire flap, except toward the radial side on the palmar surface and over the stump of the little finger, where there was some anæsthesia. The Thiersch



FIG. 10.—Photograph of hand after fourth stage of plastic, lateral radial aspect, showing degree of flexion at wrist.

graft on the chest took about 85 per cent. From then on the remaining small granulating areas rapidly healed, and the hand stump was then covered by a rather well-nourished, loose full-thickness graft enveloping it like a mitt with a relatively insignificant scar along the distal extremity of the stump running down the radial side to the thenar eminence. (Fig. 10.) By diligent exercise the patient gradually regained practically normal extension of the elbow, and extension of the wrist to nearly 180° , with flexion of the wrist almost normal. He also acquired fairly good motion in the phalangeal stumps of the ring and little fingers, but there was no motion in the phalangeal stump of the thumb. There was no interference to the elevation of the arm from the chest scar. Sensation also became practically normal except for a small area over the stump of the little finger, where it was somewhat diminished.

September 25, 1931, the fifth stage of the repair was done by the construction of a radial-dorsal flap made by incising the skin between the metacarpal of the middle and ring fingers, continued through the scar at the distal extremity of the stump. The metacarpal bone of the index finger with the adjacent intrinsic muscles and tendons was excised, a disarticulation being done at the metacarpal-carpal articulation. A similar ulnar-palmar flap was

then formed by continuing the incision through the scar at the end of the stump into the scar at the radial side, the old skin scar being elliptically excised. The flaps were made in this manner so as to have only one line of cicatrix on the thumb stump. The thumb was then bluntly separated from the balance of the hand down to the attachment of the metacarpal bone to the carpus. Both flaps were then incised transversely at their upper edges, the palmar toward the ulnar side and the dorsal toward the radial side, and then swung around and sutured in the typical manner as in the Didot operation for syndactylism, the ulnar-palmar flap to the dorsum of the hand, and the radial-dorsal flap to the palmar surface of the thumb. The former flap could be sutured almost completely without great tension, except at the upper portion. The thumb was also relatively well covered except at the upper portion. The triangular apex of the flap on the tip of the thumb stump was

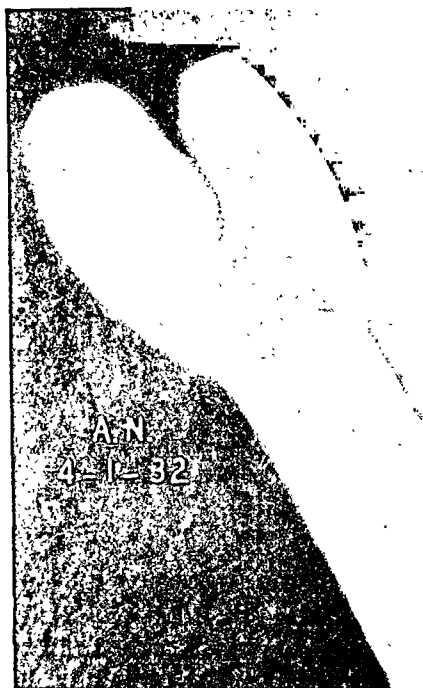


FIG. 11.—Photograph of hand after final plastic and complete healing, palmar aspect.



FIG. 12.—Photograph of hand after final plastic and complete healing, lateral radial aspect, showing ability to grasp fork.

fitted in to cover the end of the thumb very satisfactorily. A dry dressing separating the thumb from the balance of the hand and a palmar splint with the wrist in as great extension as possible were applied.

Uneventful convalescence again occurred and the sutured portion of the hand healed by primary union with perfect vitality of both flaps. October 7, 1931, a Thiersch skin-graft from the left thigh was made to the exposed areas on the palmar surface of the thumb stump and on the dorsal surface of the stump of the balance of the hand, and also in the cleft between the thumb and the remainder of the hand, all granulating areas being completely covered. Silver-foil dressing was applied. The skin-graft took 100 per cent.

From then on the wounds remained healed except that several superficial furuncles around the distal extremity of the finger stump of the hand developed. These persisted rather longer than usual, healing very slowly, undoubtedly due to a certain amount of trophic disturbance. When the hand gets cold, the distal extremities of both finger and thumb stumps become bluish-

PLASTIC RECONSTRUCTION OF HAND

red and blanch on pressure, the color returning rather sluggishly. The nutrition, however, is gradually improving. The subcutaneous fat has, to a certain extent, atrophied. The motion at the wrist has remained about the same—flexion almost normal and extension to nearly 180° . The patient has been gradually developing the motion in the thumb stump, which he can now adduct and abduct fairly well, and oppose slightly. With the movements in the phalangeal stumps of the middle and ring fingers he has acquired quite some prehensile power, being able to grasp objects—like a fork and pencil,



FIG. 13.—Final radiograph showing absence of index metacarpal with phalangealization of thumb. Also note apparently spontaneous complete disappearance of stump of proximal phalanx of middle finger and partial absorption of proximal phalanges of thumb, ring and little fingers.

or even a sheet of paper or necktie—with comparative ease, and to hold them rather tightly. (Figs. 11 and 12.)

The last X-ray examination shows, of course, the phalangealization of the thumb, and the absence of the greater portion of the metacarpal bone of the index finger. Apparently at the time of the excision of this bone a small wedge-shaped portion at the ulnar side of the base was not removed. This had fused with the radial side of the base of the ring metacarpal and this fusion has formed a clean-cut single articulation with the os magnum and

trapezoid bones of the carpus. The radiograph also shows a general rarefaction due to atrophy of all the bones of the hand, including the lower ends of the radius and ulna. It also shows definite absorption of the stumps of the first phalanx of the thumb, ring and little fingers. They have become not only shorter, more pointed and smoothed off at their distal extremities, but also narrower. They seem to be about one-half their original size. One very unusual feature is that the stump of the first phalanx of the middle finger, which was never disturbed at operation, seems to have completely disappeared by absorption. (Fig. 13.) It is believed that with practice the usefulness of the stump will further increase as the muscular power is developed and the motion, particularly opposition of the thumb stump and extension of the wrist, improves. It is also felt that the subcutaneous fat will still further atrophy, and that this will also add to the utility of the stump. The resection of some of the rather excessive skin at the end of the thumb stump might be considered, and the operative removal of some of the subcutaneous fat might also be done at a future date, if it does not atrophy sufficiently. Further usefulness might also be obtained by a suitable prosthesis.

CHOLECYSTECTOMY IN A CASE OF INTRAHEPATIC GALL-BLADDER

DR. DEWITT STETTEN reported the case of a man, aged forty-five years, who gave a typical history of gall-bladder disease dating back to twelve years ago, when he had a characteristic attack of epigastric pain radiating to the right side with vomiting but without jaundice. He had no further attack until seven years later when he again had severe pain, vomiting without jaundice, and rise of temperature to 102.5° . His present attack began about one month before admission to the hospital with pain, which has recurred on and off since. At the beginning of this attack the patient was jaundiced for a short time. On examination there was marked sensitiveness and moderate rigidity just below the right costal margin. The jaundice had disappeared.

Operation at the Lenox Hill Hospital; longitudinal right hypochondriac incision. Rather dense omental adhesions to the upper surface of the right lobe of the liver and some to the under surface of the outer edge of the right lobe. When these adhesions were freed and the edge of the right lobe of the liver thoroughly exposed, no gall-bladder at all could be found, although the duodenohepatic ligament could readily be recognized below what appeared to be the right lobe of a somewhat congested, firm liver. The foramen of Winslow was patent and no calculi could be palpated in what appeared to be the common bile-duct or at the papilla of Vater. The liver (Figs. 14 and 15) was entirely anomalous with a marked lobulation of the lateral portion of the right lobe, which was almost completely divided by means of a deep lateral fissure into a smaller outer and a larger inner portion. At the point that corresponded to the normal bed of the gall-bladder there was another deep fissure between two portions of the medial part of the right lobe which were adherent to each other. A large, somewhat pedunculated quadrate lobe, attached to the liver to the right of the hilus by a rather narrow bridge of liver tissue could be seen protruding below the right lobe, just beneath this latter fissure. Following this fissure backward and palpating the upper surface of the right lobe of the liver where the omentum had been adherent under the diaphragm, a very much thickened gall-bladder could be felt completely surrounded by liver tissue. In the gall-bladder could be palpated a solitary rounded calculus the size of a hazelnut. The left lobe was also somewhat lobulated. The falciform ligament did not as usual separate the right from the left lobe, but emerged from the centre of the liver a rather deep groove

CHOLECYSTECTOMY IN A CASE OF INTRAHEPATIC GALL-BLADDER

near the centre of the organ, which abruptly became shallower toward the anterior edge, where it terminated in a small notch, indicating the division between the two main lobes. Both the upper and under surfaces of the left

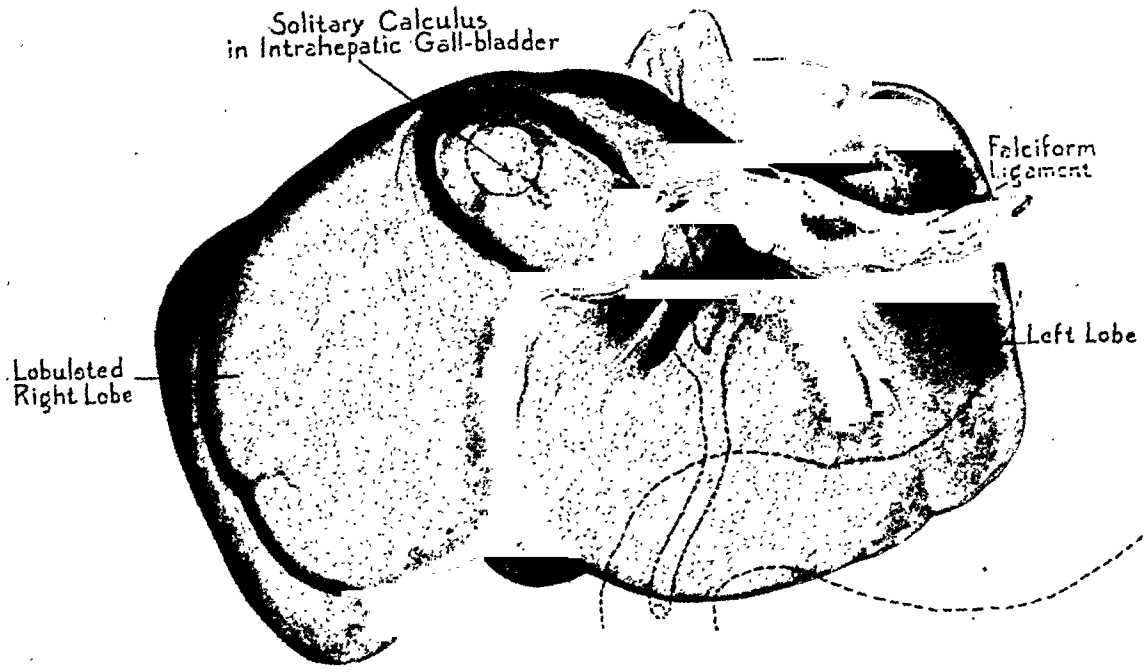


FIG. 14.—Upper surface of liver in case of intrahepatic gall-bladder.

lobe showed several marked indentations, indications of incomplete lobulation. It was found that the fissure in the liver leading to the gall-bladder could be separated without much difficulty so that the medial part of the right lobe

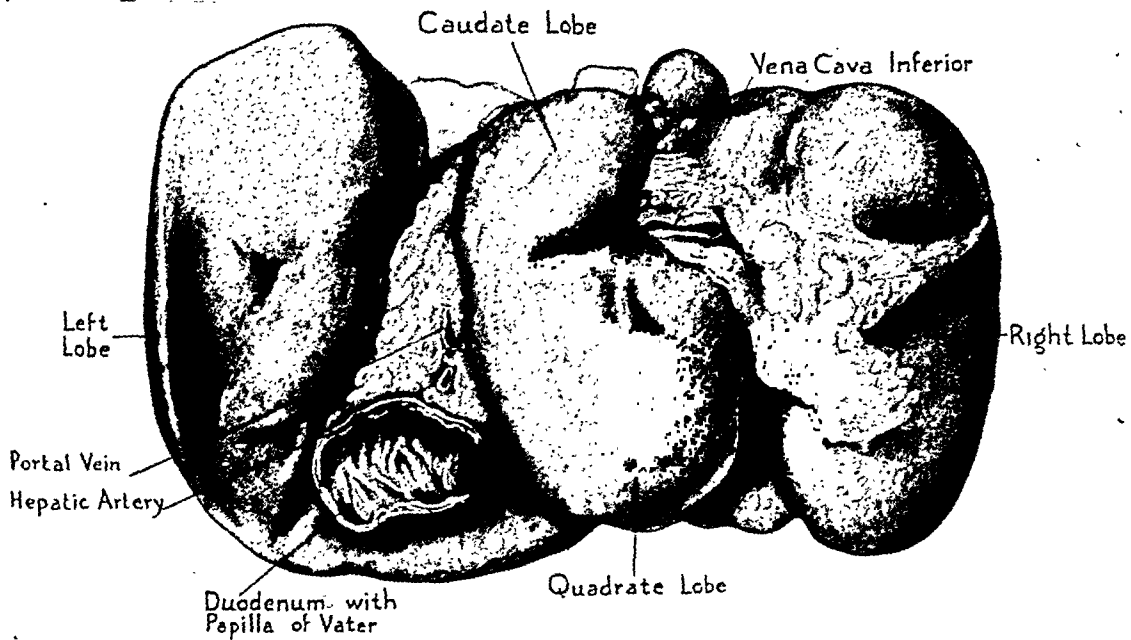


FIG. 15.—Under surface of liver in case of intrahepatic gall-bladder.

could be split apart and the large lip of liver tissue to the left could be deflected medially, and a relatively simple cholecystectomy from above downward could be done, with very definite separate ligation of the cystic vessels and cystic duct and cauterization of the cystic-duct stump. The gall-bladder

was rather adherent to its bed in the liver and there was a very profuse hæmorrhage from this region, which could be fairly well controlled with gauze tamponade, but which baffled somewhat protracted attempts at clamping or suturing, owing to its inaccessibility under the costal arch and diaphragm. It was finally decided to leave the tampons in the oozing liver bed, and the abdomen was closed in the usual manner.

The gall-bladder was a much diseased, thick-walled organ, the mucosa showing a large gangrenous patch near the fundus on the liver bed side. The balance of the mucosa was scarred. The gall-bladder contained a solitary, rounded, somewhat roughened, brown calculus the size of a hazelnut. It also contained a moderate quantity of thick, muddy, brown fluid. Microscopical examination of the gall-bladder revealed a chronic ulcerative cholecystitis. The patient was very much shocked after the operation and in spite of multiple transfusions, hypodermoclyses and proctoclyses, never really reacted. The wound drainage was rather sanguinous at first but rapidly became serous. There was never any actual post-operative hæmorrhage. The patient, however, developed a rising temperature and pulse rate, abdominal distention and tenderness and vomiting, symptoms suggestive of peritonitis, and expired about fifty-eight hours after operation. A study of the liver entirely confirmed the operative findings. In addition, a small, irregularly ovoid lobe about the size of a hen egg was found at the upper posterior portion of the right lobe, just to the right of the groove for the inferior vena cava. It was almost completely separate from the main organ, being attached by an extremely thin strand of liver tissue. The relations of the common bile-duct, portal vein, hepatic artery, inferior vena cava, and caudate lobe were relatively normal. The hepatic ducts were not dissected out as it was desired not to damage the unique specimen.

This case illustrates an anomaly that is said to be not uncommon, but which Doctor Stetten has encountered for the first time. Mentzer in the *Journal of the American Medical Association* of November 17, 1929, refers to this condition and speaks of cases reported by Wieder, Lemon, Deve, O'Day, Yoell, Schachner, Kehr, and himself. He regards the condition as a revision to the form normally occurring in certain of the lower animals. The case is reported by Doctor Stetten because he believes that, had the technical difficulties and dangers been properly anticipated, a cholecystectomy would not have been attempted. The gall-bladder could have been opened, the calculus extracted, and a simple cholecystostomy performed. This might not have been entirely simple, owing to the position under the diaphragm, but with some sort of L-tube, it might have been accomplished. Death was undoubtedly caused by shock, and peritonitis, resulting from hæmorrhage, protracted manipulation, and the subsequent necessity for extensive gauze drainage, which could have been avoided by the simpler operation.

PARA-ŒSOPHAGEAL ABSCESS

DR. ARTHUR S. McQUILLAN presented a woman who entered Bellevue Hospital, October 22, 1931, with a tender indurated swelling in the region of the left lobe of the thyroid gland. There was a sense of deep fluctuation in this region. The swelling appeared maximum at the inner border of the sternomastoid at its middle. About ten days before admission to the hospital, she had swallowed a fish bone, which she felt lodged in the upper œsophagus. The bone remained there for one week, when she dislodged it by gargling but soreness and pain in the left side of the neck persisted.

Over the maximum swelling about the middle of the sternomastoid, a three-inch transverse incision was made under local anæsthesia. Thick pus

RECURRENT DIVERTICULUM OF THE ŒSOPHAGUS

welled up from an opening between the sternomastoid and omohyoid muscles. About three ounces of pus was evacuated and this had the odor of colon bacillus—which was proved by culture. This abscess cavity was found to lead down to the cervical vertebræ along the side of the œsophagus. With drainage the patient made a good recovery in two weeks.

The reason for presenting this case is for the interest attached to infections in this para-œsophageal space and the relation of these infections to œsophageal diverticula.

RECURRENT DIVERTICULUM OF THE ŒSOPHAGUS

DOCTOR McQUILLAN presented also a woman who was presented before the New York Surgical Society December 11, 1929. Three months previous she had had a two-stage operation for diverticulum of the cervical œsophagus on the left side. The patient remained symptom-free for a period of nine months, when she began to have distress in swallowing and all the former symptoms reappeared with increased severity.

X-ray showed a diverticulum on the same side nearly as large as the first one. Molds of food as large as one's thumb were regurgitated from this sac. A No. 18 œsophageal bougie easily entered this sac, and one could feel this bougie by palpating on the left side of neck. It was impossible to get this bougie to pass the sac into the lower œsophagus.

Operation was undertaken, October 31, 1930, through the old scar. There were scarcely any adhesions, and no difficulty in identifying and isolating the diverticulum, which was much larger than appeared in the X-ray. In fact the sac was found to be formed by the whole left side of the cervical œsophagus, there being no distinction between neck and fundus. Also, the wall of the sac was exceedingly thin, which is contrary to the usual findings in œsophageal diverticula.

It was obvious that any attempt of excision would result in extirpation of the whole left wall of the œsophagus. For this reason the sac was obliterated by a multiple infolding or plication of its wall, with an œsophageal bougie in place to prevent obliteration of the entire lumen.

With the exception of a hoarse voice lasting three weeks, the patient made a good recovery and has been symptom-free to the present time. However, X-ray shows beginning diverticulum on the right side, which has given no symptoms thus far.

DR. GASTON A. CARLUCCI quoted a similar case under his care in 1927. Recently she returned to have another X-ray taken. The diverticulum had been removed in one stage, after which the patient had no symptoms. Now, five years later, she had a little diverticulum present. The original removal was by complete extirpation, the end being turned in.

DR. FRANZ TOREK said that recurrences happened after all kinds of operations for diverticulum of the œsophagus. In the one-stage operation they recur less frequently than in any other. The preference for the two-stage operation has been based on the belief that it is safer as far as mortality is concerned. Thirty years ago the mortality was very high with the one-stage procedure, but in the last five years sixty cases have been recorded with a mortality of only one. The most certain result as far as absence from recurrence is concerned is the one-stage operation.

TRANSACTIONS OF THE PHILADELPHIA ACADEMY OF SURGERY

STATED MEETING HELD APRIL 4, 1932

The President, DR. JOHN SPEESE, in the Chair
CALVIN M. SMYTH, JR., M.D., Recorder

VENTRAL HERNIA—HERNIOPLASTY—LIPECTOMY

DR. HUBLEY R. OWEN presented a woman, aged fifty-six years, who was admitted to the Philadelphia General Hospital January 22, 1932, with the chief complaint of incisional hernia. In 1925, she had had laparotomy for prolapse of the uterus and a second gynecological operation in 1930. Shortly after the second operation she fell heavily to her knees and thereafter noticed a swelling in the abdominal wall which had been increasing in size and for the past few months has been painful.



FIG. 1.



FIG. 2.

FIG. 1.—Ventral hernia before operation.

FIG. 2.—Result of operation on condition shown in Fig. 1. Photo taken four weeks after operation.

The examination of the abdomen disclosed below the umbilicus a large misshapen protrusion which hung like an apron (Fig. 1) along with natural adiposity over pubis. This mass contained gurgling gut. An ill-defined rectus diathesis could be palpated.

At operation, two longitudinal, elliptical incisions were made from below the ensiform cartilage to above the symphysis. Subcutaneous tissues and peritoneum dissected free of hernial sac. An area of skin and subcutaneous tissue measuring ten inches by nine inches was removed. The contents of hernial sac were replaced in the abdomen. Peritoneum was closed and both the posterior sheath and the anterior sheath of the rectus muscle were overlapped and sutured with interrupted No. 2 chromic gut. When the closure

SPLENIC ABSCESS

of the skin and subcutaneous tissue was undertaken it was found on account of the large amount of tissue removed that it was necessary to "pie-crust" (Fig. 2) on either side of the suture line in order to relieve the strain on the skin sutures. The patient was discharged February 16, 1932, twenty-one days after operation.

LOCALIZED TUBERCULOSIS OF THE CHEST-WALL

DR. RICHARD H. MEADE, JR., read a paper with the above title for which see page 247.

ELEPHANTIASIS NOSTRA

DR. GEORGE P. MULLER and (by invitation) DR. CLAUS G. JORDAN read a paper with the above title for which see page 226.

SPLENIC ABSCESS

DR. ELDRIDGE L. ELIASON reported the case of a man, aged twenty-three years, who was admitted July 21, 1931, to the Medical Service of the University of Pennsylvania Hospital, complaining of pain in the left side of chest following rupture of a left peritonsillary abscess. He had developed sore throat June 16, 1931, and was admitted to the hospital June 20, 1931, after a fainting spell, associated with a very high fever. While in the hospital a left peritonsillar abscess ruptured June 25. On the next day a severe pain was noted in left side of the chest near costal margin in the anterior axillary line. This pain spread to entire left upper quadrant of the abdomen. Decided tenderness to palpation was noted over the left upper abdominal quadrant. The patient was coughing up profuse mucopurulent sputum and was experiencing nausea, vomiting, weakness and sweating. He had had definite chills and his temperature was 104.2° .

Fluoroscopical examination of the chest July 22 disclosed a small empty abscess cavity in the right upper lung, with a fluid level beneath the diaphragm on the left side lateral to the stomach; and a fixed left diaphragm indicative of subdiaphragmatic abscess. X-ray examination July 25 showed in the lateral view that the abscess in the right lung was in the base of the upper lobe. A blood culture showed a staphylococcic septicæmia. A surgical diagnosis of (1) splenic infarct with abscess formation secondary to acute tonsillitis was made and drainage advised; (2) lung abscess and septicæmia (the former appears to be draining adequately by the postural method of treatment).

Following a transfusion of 250 cubic centimetres of blood the patient was operated upon July 27 through a left modified Kocher incision. On opening the peritoneal cavity there was a gush of reddish-gray purulent matter, evidently under pressure and accompanied by a malodorous gas, comparable to that draining from the peritonsillar incision. Approximately one litre of pus evacuated. Pulp-like tissue escaped in shreds, not unlike splenic pulp. Soft rubber tissue cigarette drains were inserted and wound packed with plain gauze. The pulse was 160 at the close of operation, which took fifteen minutes. The patient was again transfused after operation, but he became progressively worse and succumbed about twenty-seven hours later. The post-operative course was marked with a severe hyperthermia, the temperature reaching 108° .

At an incisional post-mortem, the spleen was found the seat of an enormous abscess which had ruptured, causing a localized subdiaphragmatic abscess bounded by the liver, stomach, colon and lateral abdominal wall. It

contained pus and small quantities of soft mushy tissue, which on extraction were found to be portions of the spleen which had undergone necrosis and sequestration. The right lung showed a large abscess. Further exploration was not permitted.

DOCTOR ELIASON remarked that abscess of the spleen is thought to be a rare disease. This fallacious idea is due to the fact that it is rarely reported as such, because it is seldom diagnosed and treated surgically. It is, however, frequently found at post-mortem as a complication in septicæmia, typhoid fever, relapsing fever, *etc.*, its existence before death not being suspected or rather being masked by the serious nature of the primary disease. The above case was diagnosed and treated surgically although with fatal result. It illustrates also the sequestration phenomenon noted by Kuttner in his series of abscessed spleens.

ECHINOCOCCUS CYST OF THE LIVER

DOCTOR ELIASON reported the case of a man who was admitted to the hospital of the University of Pennsylvania April 7, 1927, complaining of severe pain in the mid-epigastrium. The patient had been perfectly well until three years and five months before admission, at which time he was seized with a severe pain in his upper abdomen which doubled him up, persisting for ten minutes, and then disappeared entirely. These attacks became periodic in type, recurring at intervals of from three weeks to two months, and lasting from ten minutes to twelve hours each time. Soon after the original attack the patient was admitted to the New York Polyclinic Hospital where X-ray studies and duodenal drainage were done. He was informed that all examinations at that time were negative. The pain had no relation to food and was not accompanied by nausea, vomiting, dizziness or headache. It was severe, usually localized in the mid-epigastric region, though it occasionally radiated through to the interscapular region posteriorly. Nausea and vomiting appeared as a feature only with the attack immediately before the patient's admission to the hospital. There were no other gastro-intestinal symptoms in the patient's past history and the cardiorespiratory, nervous and urological systems were negative.

When admitted the upper recti were markedly rigid and there was definite tenderness about one inch below the ensiform cartilage in the mid-line. The lower recti were soft, the liver, spleen and kidneys were not palpable and no other masses were made out. Peristalsis was absent. The leucocyte count on admission was 22,300. The fluoroscope revealed a large mass extending upward from the anterior portion of the right lobe of the liver, considered to be probably non-inflammatory since the diaphragm moved readily above it. In view of this finding immediate operation was postponed. The following morning the abdomen was soft, the temperature, pulse and respirations normal and the patient felt quite comfortable. The leucocyte count had fallen to 11,900. Because of the X-ray findings, the slight icterus and the patient's nationality (Greek), a tentative diagnosis of echinococcus cyst of the liver was made which was further confirmed by the presence of a positive complement fixation test for hydatid disease.

The following day a portion of the right tenth rib in the mid-axillary line was resected, the diaphragm was sutured to the pleura and the wound packed with gauze. Two days later a needle inserted into the cyst cavity obtained typical "spring water" fluid and a cautery was carried along its

ECHINOCOCCUS CYST OF THE LIVER

course toward the cyst. As there did not appear to be sufficient adhesions present between the liver and the diaphragm at this time, however, and to prevent the possibility of peritoneal soiling, the wound was again packed with gauze for three days. May 2, 1927, the cyst was entered by means of the cautery. It was found to be about the size of an orange, filled with daughter cysts of all sizes and containing a quantity of yellow mucoid material. After removing many of the cysts the cavity was packed with gauze. Four days later the gauze was removed and the cavity explored by means of a cholecystoscope. Many small daughter cysts were found lining the wall of the cyst cavity; about a cupful of these were removed with moderate difficulty. During the next few days the general condition of the patient rapidly improved, the drainage from the cyst cavity decreased and he was discharged to the surgical out-patient department. Four months later he was enjoying excellent health, at his old work and symptom-free.

The patient had no symptoms until January 1, 1932, when, after a heavy meal, he again experienced a moderately severe pain in the epigastrium which continued for twelve hours. This was followed by a feeling of soreness which extended from the epigastrium down to the anterior superior spine on the right. For the next four days he remained in bed, felt feverish and experienced several chills, although his appetite was good and there was no digestive upset. He was admitted to the hospital January 5, 1932, with a temperature of 99°, pulse 84 and respirations 20. In the abdomen a large mass was palpable extending down from the right costal margin to the level of the umbilicus. The mass moved with respiration, had a definite edge, was moderately tender and extended on percussion to the fourth right interspace in the mid-clavicular line. Recurrent echinococcus disease of the liver was evident. Surgical drainage was instituted by means of the transthoracic approach in two stages. The cavity in the right lobe of the liver was found to be about the size of an adult fist. From this approximately a cupful of daughter cysts of varying size were removed. At operation the cysts were seen attached to all sides of the cavity. Palpation revealed the presence of some calcification in the wall of the cavity beneath the daughter cysts. The cavity was packed with gauze and a large drainage tube inserted. Post-operatively the patient drained great quantities of bile-stained serum, in which many daughter cysts could be seen. Irrigations with 1.5 per cent. iodine solution were instituted but the pain incident to these irrigations was so great that they had to be stopped even though the concentration was reduced to .5 per cent. An X-ray plate taken after the injection of lipiodol into the sinus showed the entire hepatic duct system plainly outlined, the ducts appearing somewhat larger than normal. The hepatic ducts and the common duct were particularly dilated, but a small portion of the lipiodol was seen to enter the duodenum. This plate demonstrated conclusively an existing connection between the echinococcus cyst and the biliary tree and suggested the presence of some obstruction in the common duct. The patient continued to discharge great quantities of bile through the wound, although there were no signs of biliary insufficiency manifest. The biliary drainage decreased gradually though he continued to require two dressings per day. March 1, 1932, the patient was discharged to the care of his family physician. At this time there was no jaundice, the stools were brown and he was free from all symptoms except the profusely discharging biliary fistula at the operative site.

March 10, 1932, the biliary drainage from the fistula ceased and coincident with this the patient developed chills, fever, pain in the epigastrium and became definitely jaundiced with acholic stools. His physician probed the

biliary sinus which resulted in a great outpouring of bile and the jaundice with its accompanying symptoms promptly disappeared within the next few days. The man was again admitted to the hospital March 17, 1932. On this admission there was no definite jaundice although the sclera had a subicteroid tinge. The biliary fistula in the right chest continued to discharge copious quantities of bile each day. The stools were brown and the urine showed no bile salts. Under gas-ether the abdomen was opened through a modified Kocher incision. The gall-bladder was of normal thickness and color, was not distended and contained no stones. Palpation of the superior surface of the liver showed this tightly adherent to the right diaphragm. There were many adhesions along the cystic and common ducts. The cystic duct was but slightly dilated, while the hepatic duct when seen was found to be greatly enlarged, being approximately the size of one's thumb. The common duct as it passed behind the duodenum was also seen to be similarly dilated. The gall-bladder was opened and found to contain no bile. It was then carefully explored with the cholecystoscope but no calculus was found which might account for the absence of bile from the gall-bladder. The hepatic duct was then opened and found to be filled with bile in which streaks of purulent material were noted. A catheter introduced into the common duct through the hepatic duct readily entered the duodenum. Flushing out the common duct with normal salt solution failed to disclose the presence of any calculus or daughter cysts in this portion of the ductal system which might be responsible for the obstruction. The catheter was then passed up the hepatic duct into the liver. Approximately five centimetres up the hepatic duct, within the liver, a partial obstruction was encountered, although the catheter could be forced by this point. Instilling salt solution in the hepatic duct through the catheter resulted in the discharge of several small typical daughter cysts through the opening in the hepatic duct. It was therefore felt that the obstruction was of the partial type, due to the transplantation of echinococcus cysts, located high in the hepatic ducts. Drainage of the common duct or a cholecyst-duodenostomy in such a case would serve no useful purpose so the incision in the hepatic duct was closed and a drain placed to this site. A cholecystostomy was performed and the abdomen was closed. Post-operatively the patient did well. Small quantities of bile were discharged through the cholecystostomy tube although the biliary sinus in the chest continued to discharge considerable quantities of bile requiring daily dressings.

INTRAMURAL ABSCESS OF THE STOMACH

DR. L. K. FERGUSON reported the case of a colored woman, thirty-eight years old, admitted in the service of Dr. E. L. Eliason at the Philadelphia General Hospital March 29, 1931, complaining of severe epigastric pain. Following a drinking party one week before admission, the patient had an attack of acute upper abdominal pain associated with marked vomiting and elevation of temperature. Her pain continued and became localized slightly to the right of the mid-line in the epigastrium. There was radiation of the pain to the back and to the right shoulder. Two years before admission the patient had a severe gastric hæmorrhage which was thought to be due to a gastric ulcer. Since that time she had suffered from occasional gastric upsets usually following the taking of alcohol in excess.

There were no abnormal signs in the lungs. The abdomen was distended and was markedly tender and rigid in the epigastrium, especially on the right side. No masses were palpable. Peristalsis was greatly diminished. A scar of a previous operation in the lower abdomen was not tender. The blood

count showed 4,620,000 red cells and 21,200 white cells of which 92 per cent. were polymorphonuclear leucocytes. A flat plate of the abdomen showed no gas under the diaphragm and was reported as not suggestive of a ruptured viscus.

The abdomen was opened through a right rectus incision under spinal anæsthesia. A small amount of clear, straw-colored fluid was aspirated. An examination of the stomach showed a diffuse thickening of the pyloric end, more marked on the lesser curvature and anterior wall. There was marked œdema of the tissues of the gastrohepatic omentum which extended upward to involve the subhepatic structures. The gall-bladder was indurated but did not contain any stones. Clear, yellowish bile was aspirated from it. No pathological condition could be found in the lesser peritoneal cavity. A cholecystostomy was performed and the wound was closed about the tube.

The first post-operative day was uneventful. On the second day the abdomen became distended and peristaltic sounds were diminished. Glycerine enemas appeared to relieve the distension somewhat. Temperature and pulse gradually increased. On the evening of the third day when the distension was still marked the patient was found out of bed. During the night she was delirious and incontinent. The pulse and temperature gradually mounted, the distension increased and the patient died on the morning of the fourth post-operative day.

Post-mortem examination revealed a generalized fibrino-purulent peritonitis. The stomach was the seat of an acute phlegmonous process. About two centimetres above the pylorus there was an abscess lying between the mucosa and muscularis. The abscess cavity was about six centimetres in diameter and contained about ten cubic centimetres of fluid pus. There was marked induration and œdema of the surrounding stomach wall. The duodenum also was involved in the acute inflammatory process and there were many ulcerations of the mucosa.

DOCTOR FERGUSON remarked that Rankin and Miller have recently reported that abscesses of the gastric wall form about 12 per cent. of the purulent inflammatory lesions of the stomach. They occur so infrequently, however, that the diagnosis is rarely made except at operation or at necropsy. As a rule they represent an advanced stage of phlegmonous gastritis, the exciting causes of which may be grouped under five general heads: food, alcohol, chemical irritants, infections and infectious fevers. In addition, local inflammatory lesions may be set up by occupational, accidental or operative trauma to the stomach wall. The abscesses are usually located in the sub-mucosa but they may involve all the layers of the stomach.

The predominating organisms are usually streptococci or staphylococci and occasionally pneumococci. The surgical treatment of gastric abscess is attendant with a very high mortality. Incision and drainage, excision and drainage and gastric resection have occasionally been used in the treatment of this condition. It occurs so rarely, however, that the lesion is often not diagnosed even at operation. Symptoms of gastric abscess are varied. The patients are usually young and often the history may be obtained of an alcoholic debauch or some food intoxication. There is sudden loss of appetite, nausea and vomiting occur, and vomiting becomes a prominent symptom. As a rule, the fever is high, varying between 103° and 105° and is often of the

septic type. On examination there is marked pain and tenderness in the epigastrium, at times referred to the back and to the shoulder. The X-ray findings usually are interpreted as gastric ulcer.

MUSCULOSPIRAL PARALYSIS—TENOPLASTY

DR. GEORGE M. DORRANCE presented a boy, aged nine years, who was admitted to St. Agnes' Hospital September 1, 1931. Four years prior to admission this child was struck by an automobile and sustained a compound fracture of the humerus and severe laceration of the upper arm. He was treated in another institution. All the muscles of the upper arm were torn loose from their points of insertion and the skin and fascia was devitalized over a large area. The musculospiral nerve was exposed and during the fifteen weeks' stay in the hospital, it ruptured and the ends became buried in the scar tissue. The infection cleared up before his discharge. He had practically no power to raise his forearm; he had wrist drop. One year prior to his admission to St. Agnes' Hospital, Doctor McShane and the reporter reunited the ends of the musculospiral nerve but as there was no return of function he was admitted for a tendon transplantation. September 2, 1931, the following operation was performed: The tendon of the flexor carpi radialis was cut close to its insertion at the base of the second and third metacarpal bones; the tendon of the flexor carpi ulnaris was also cut close to its insertion in the pisiform bone. Next the four tendons of the extensor communis digitorum and the extensor longus pollicis were exposed just above the posterior annular ligament. Each of these tendons was slotted—then the free end of the tendon of the flexor carpi radialis was threaded through from the radial side and drawn out for a distance of one inch on the ulnar side. The flexor carpi ulnaris tendon was threaded through from the ulnar side and drawn out for an inch on the radial side. The free ends were turned back on themselves and sutured. A suture was placed through each of the tendons also at the openings in the communis digitorum and extensor longus pollicis. The wounds were closed and for four weeks the arm was placed in a plaster case with the wrist extended. After four weeks massage was begun and passive motion instituted. The child was encouraged to move the wrist. Almost complete restoration of the power of extension was accomplished by this procedure.

March 31 the patient was examined by Dr. Milton Meyers who tested the extensor muscles and the supinator longus to see if the musculospiral nerve had regenerated, so perfect was the function. Doctor Meyers had examined this patient before the operation and reported that the muscles supplied by the musculospiral had undergone atrophy and showed signs of degeneration. Today he reports partial return of musculospiral function. This illustrates the point that return of function after nerve suture may not manifest itself for eighteen months or longer.

TEMPOROMANDIBULAR ANKYLOSIS

DR. GEORGE M. DORRANCE presented a girl, aged six years, who was admitted to St. Agnes' Hospital November 21, 1931, with the diagnosis of bony ankylosis of the left temporomandibular joint. At the age of one year, a large cervical abscess complicating septicæmia developed. Incision and drainage was performed and the patient was under medical supervision for four months. Eight months later, she developed a septic sore throat. In attempting to treat this, the physician forcibly opened the jaws. Since then, according to the mother, the jaws became fixed. Physical examination was negative

ARTHROPLASTY OF JAW FOR ANKYLOSIS

except for the complete bony ankylosis of the left side of the jaw. X-ray showed atrophic bone changes in articular process of the left side and complete bony ankylosis.

November 13, 1931, under ether anæsthesia, resection of the left mandibular joint was done. Not only was the condyle fixed but the coronoid process was fixed by ossification to the base of the skull. It was necessary to resect about one inch of the bone. Convalescence was complicated by an acute otitis media but was otherwise uneventful. The patient was instructed to open and close the jaws every fifteen minutes after the tenth day. This procedure was painless from the start—the chewing of gum proved to be a valuable adjunct in keeping the jaws in motion. At the present time she has no difficulty in opening the jaws to the normal limits.

RESECTION OF MANDIBLE

DR. GEORGE M. DORRANCE presented two patients operated upon for malignancy of the jaw. The first patient was a man who was operated upon twelve years ago by the later Dr. Francis T. Stewart, at Jefferson Hospital, for a multilocular cyst. Recurrence of the condition led the reported to do a resection of the lower jaw, after having ligated the external carotid artery.

This man has had metastasis to the glands of the neck, a fact not sufficiently emphasized when discussing the relative benign nature of adamantinomas. He wears a double inclined plane appliance made by Doctor Webster and has little deformity and can masticate quite satisfactorily.

The second case was that of a woman who had had one-half of the jaw resected for a sarcoma. She does not wear any splint or appliance. Unfortunately, a local recurrence necessitated removing the bone well beyond the mid-line into the second incisor area on the opposite side. Doctor Dorrance has been agreeably surprised to find that while this procedure did increase the deformity considerably, it has caused comparatively little disturbance to the patient.

These two cases were shown to illustrate the fact that when necessity dictates resection of half the jaw, the ensuing deformity need not be too seriously considered.

ARTHROPLASTY OF JAW FOR ANKYLOSIS

DR. A. BRUCE GILL presented two patients on whom an arthroplasty of the jaw had been done. The first patient was operated upon in 1927, when five years of age. When she was a baby she had pyogenic infection of the right hip which was not recognized. She was being treated for tonsillitis for a number of weeks. During that time an abscess developed in the region of the right temporomandibular joint which was opened and drained. Bony ankylosis resulted. The lower jaw did not develop with the other bones of the face. At the present time she has normal mobility of the jaw and the lower mandible has developed almost to normal size.

The second patient was operated upon January 21, 1932. She is eleven years of age. The ankylosis of the temporomandibular joint occurred when she was two years of age. At the time she was in the Municipal Hospital for a period of sixteen weeks with scarlet fever, diphtheria, pneumonia, mumps and measles in succession. She had a blood-stream infection which produced abscesses in the left thigh and the left arm and wrist. A bony ankylosis of both temporomandibular joints resulted. Bilateral arthroplasty was done. At the present time she is able to open her mouth about one and a half inches and the range of motion is increasing

Doctor Gill did his first operation for this condition in 1919. His method of operation has always been as follows: Incision is made through the skin about one inch in length along the lower border of the zygoma. Another incision of the same length at a right angle to the first one is carried down just in front of the ear. The soft tissues are divided down to the lower border of the zygoma and are pushed downward by blunt dissection. In the majority of his cases it has been found that both the condyle and the coronoid process have been ankylosed to the skull with obliteration of the sigmoid fossa. With a thin-bladed osteotome the ramus of the jaw is divided about one-half inch below the lower border of the zygoma and then the upper portion of the mandible is separated from the zygoma in the same way. If this is done carefully no injury is done to vessels, nerves or parotoid gland. A piece of superficial fascia and fat is removed from the thigh and placed between the skull and the mandible. The wound is closed without drainage.

The after-treatment consists in keeping the mouth open with plugs made of rubber or with a wooden screw or with dental plates which have arms attached to them to which are fastened rubber bands. It has been found that these mechanical means are not needed after the first two or three weeks as the patient then begins to move the jaw freely. One case of relapse occurred in a patient in whom he did not interpose any soft tissue between the bones at the time of operation. A second operation was necessary. It resulted in good function. In practically all of the speaker's cases the condition was due to a pyogenic infection apparently accompanied by the presence of osteomyelitis in other parts of the body. After function of the jaw is established it has been found that the jaw develops. Of course, the younger the patient at the time of operation the more rapid and more complete is the result.

BRIEF COMMUNICATIONS

THE OVERSLUNG TRACTION SADDLE FRAME

FOR THE TREATMENT OF FRACTURES OF THE PELVIS
AND LOWER EXTREMITIES

THIS frame may be used where the conveniences of a fracture bed or the Bradford frame are indicated, but has many advantages over either. It provides for:

- (1) The patient to lie naturally on the mattress of the bed, thus eliminating decubitus.
- (2) Traction and fixation of lower extremities in any manner desired.
- (3) Raising and lowering of the patient without disturbing traction and fixation.
- (4) Nursing attention, such as use of the bed pan, bathing, changing linen and turning of mattress.

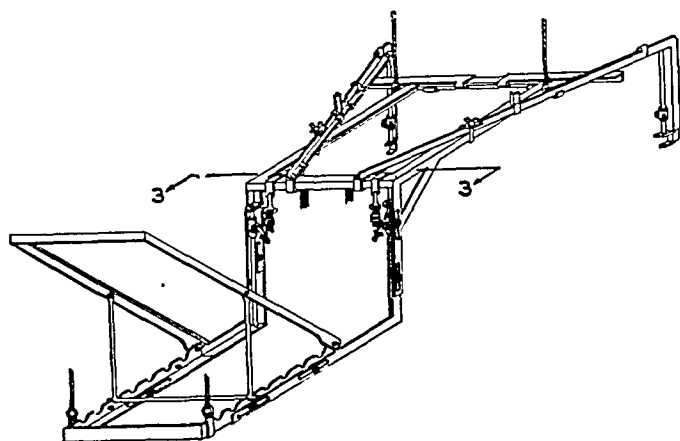


FIG. 1.—Details of frame construction.

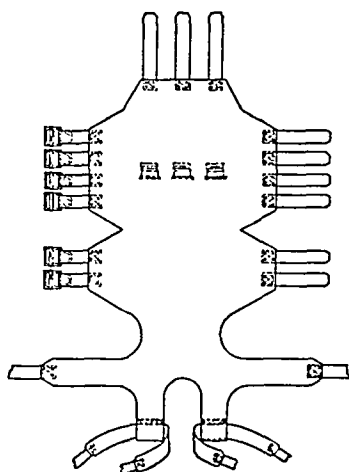


FIG. 2.—Details of canvas saddle.

- (5) Transportation of patient without disturbing fixation and traction.
- (6) Headrest adjustment and sitting position.
- (7) Tilting patient where hypostatic pneumonia is threatening.
- (8) Access to X-ray or fluoroscopic examination.

Its greatest usefulness is in fractures of the neck of the femur in the aged. The fragments may be reduced without anæsthetic or removal of patient from the bed. The reduction is slowly and painlessly accomplished by the Russell method of traction. Adhesive is applied to the leg as for Buck's extension. A band around the knee is attached to the rope which extends over a pulley above, then to triple pulleys at the foot, thus producing flexion of the knee, internal rotation and traction by a single weight.

The frame is constructed of No. 1 by 1 by 3/16 inch angle iron. (Fig. 1.) It forms a two-section rectangle, 36 inches wide and as long as the bed, in which the upper half rests on the bed mattress and supports the trunk and

pelvis by means of its canvas saddle (Fig. 2) which is stretched between the bars of the frame, while the lower half is overslung above the extremities and provides suspension, fixation and traction for them. This removes all bars and framework from under the legs so that extension or abduction of the legs may be obtained without having the interference. Two adjustable arm bars hook onto the transverse bar at the middle of the frame and extend out over the lower rectangular frame and drop down at the end to furnish support for the pulleys. Countertraction is furnished by a padded aluminum band around each thigh at the groin and hooked by snaps to the frame above. The canvas support under the back and pelvis is buckled to this band so that the patient can slide downward no farther than the tension of the canvas

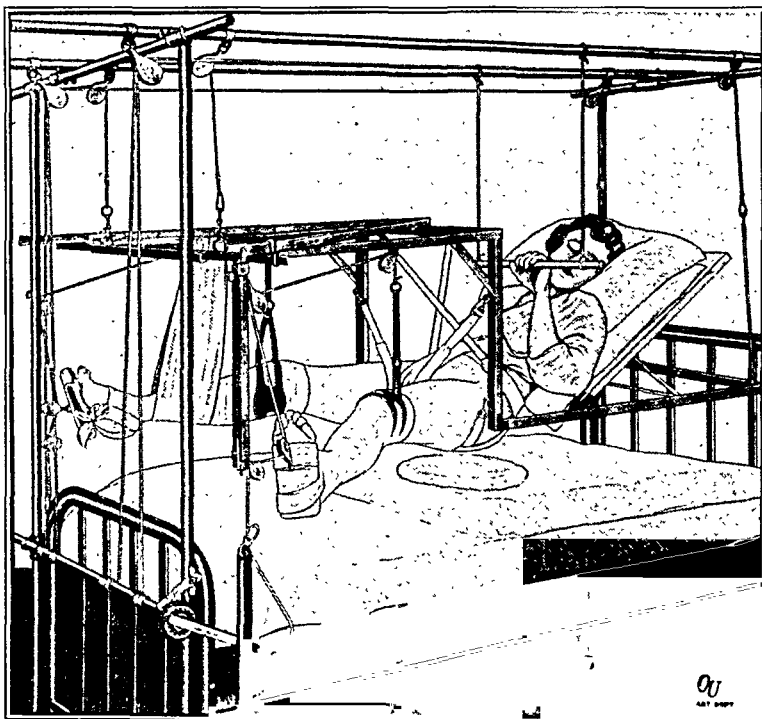


FIG. 3.—Raising and lowering of patient.

will allow. There is a headrest under the trunk so that the patient may be raised to the sitting position. The frame is suspended by a cable attached to each corner and is raised and lowered (Fig. 3) by means of a windlass and pulleys on an overhead Balkan frame. Traction to the extremities may be applied in any of the forms in common use.

EARL D. McBRIDE, M.D.
Oklahoma City, Okla.

TREATMENT OF INTRACAPSULAR FRACTURES OF THE NECK OF THE FEMUR

IN THE last (tenth) edition, 1931, of Pye's Surgical Handicraft, designed for house surgeons and dressers, the rising generation, the treatment of intracapsular fracture of the neck of the femur is described as follows:

"The patient should be propped up in bed with the limb placed between sand-bags. After about a month the patient is advised to use the limb as much as possible since union is not aimed at."

This is virtually a transcription of the teaching of Sir Astley Cooper, which was based on the conclusion that mechanical appliances were inadequate to assure the essentials of repair. Consequently, that positive treatment of the fracture was both futile and dangerous. This conclusion, which has been generally accepted, is verified by recent experience.

In 1928, Katzenstein of Berlin (*Zent. f. Chir. L. v.*, p. 239), reported on 169 cases of medical fracture treated in the conventional manner. Good results were attained in but 11.6 per cent. of the number, a percentage which, according to Auxhausen, who discussed the paper, fairly represented the general experience.

In 1930, Hübner (*Arch. f. Orth. u. Unfall. Chir.*, 1930) reported on 136 cases treated at the Charity Hospital in Berlin. Good results were attained in but 6 per cent. and passable function in 16 per cent. of the patients.

The most recent statistics available for comparison are those of Stern and Henderson. Stern has reported on the results of seventy-nine cases of medial fracture treated by the abduction method at the Mt. Sinai Hospital in Cleveland, with a mortality of 7 per cent. and union in 67 per cent. Seventeen of the patients were over seventy years of age yet union was attained in 78.5 per cent. (*Surg., Gynec., and Obst.*, August, 1931).

Henderson reports on forty-two cases treated at The Mayo Clinic. Union was attained in 90 per cent. of the patients under sixty and in 65 per cent. of those over that age. (*ANNALS OF SURGERY*, vol. xciii, p. 968, 1931.)

In all reports available for comparison, the balance, as in this instance, in favor of positive over negative treatment, must be reckoned in multiples of 100 per cent.

One may conclude, therefore, that the real obstacle to the general adoption of the abduction treatment is inertia, or more specifically, to quote Mosen-thal (*Med. Klinik*, vol. xxv, p. 384, 1929), inability to meet its requirements.

ROYAL WHITMAN
New York, N. Y.

TECHNIC FOR CARE OF OLLIER-THIERSCH SKIN GRAFTS

THE application of a graft is a simple matter but many surgeons are bewildered when it comes to the after-care. Paraffin gauze, rubber strips, adhesive plaster, wire splints, exposed wound, cello silk, marine sponge and vaseline gauze are some of the dressings in use. A recent article advocates a rigid dehydrating diet for the recipient before grafting, thus drying the granulations, which is to aid agglutination of the grafts. Practically all these dressings and methods were devised solely for the purpose of splinting or approximating the grafts until they take.

To obtain the best results in wound repair three fundamental principles

in surgery must be observed; first, there must be constant, even, gentle pressure of the opposing surfaces, that is, adequate approximation; second, there must be constant splinting of these surfaces; third, the wound must be kept free from secretions and infection. A violation of these principles in the art of skin grafting is much more disastrous than in the closure of a lacerated or an incised wound. During the first twenty-four hours the grafts become agglutinated at the base by a coagulation of lymph; this is followed gradually by connective-tissue and capillary infiltration until firm union occurs. Grafts are parasites and do not become a part of the host until about the tenth day. It is during this insecure period that it is difficult to comply strictly with these principles by the present methods, especially when the dressing is removed to cleanse the wound. To obviate this difficulty these dressings are

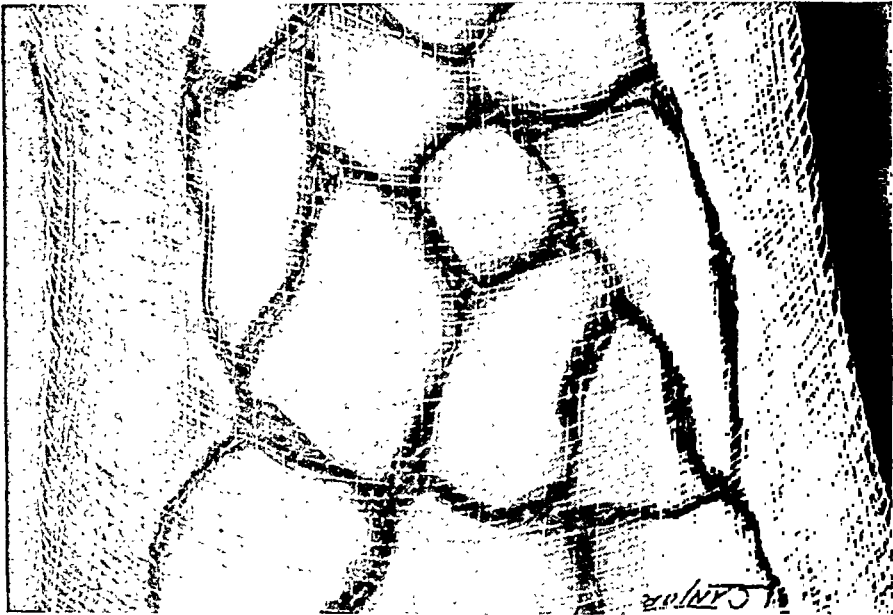


FIG. 1.—Note the granulations attached to the gauze between the grafts.

frequently left eight to ten days before removal. During this long period many grafts are autolyzed by the secretion or destroyed by the infection. By the following method the grafts are constantly approximated and splinted so that the wound may be dressed and cleansed as frequently as desired without danger to the grafts.

The technic.—Assuming that the surface to be grafted has been properly prepared and the Ollier-Thiersch grafts applied in the usual manner; then place a single layer of gauze (20 by 16 mesh) snugly over the grafted area and extend it around the limb and sew it together on the opposite side. If the grafted area is in an inaccessible place extend the gauze for a considerable distance from the wound and fix the edge with adhesive or collodion. The wound is then covered with a sterile dressing one-half inch thick and kept moist with normal saline. Within twenty-four hours the single layer of gauze becomes attached and buried in the granulations between the grafts

and shrinks sufficiently to make it taut. Thus each graft becomes enclosed in a compartment surrounded by a wall of granulation tissue, and covered with the single layer of gauze. (Fig. 1.) The top dressing can now be removed as frequently as desired (after saturating with normal saline) and the wound irrigated without disturbing the grafts in the least. There is always a certain amount of swelling due to the inflammatory reaction underneath the grafts; this with the shrinkage of the single layer of gauze, which is buried in the granulations between the grafts, gives adequate pressure to encourage union. On about the tenth day the single layer of gauze is removed. The firmness with which the grafts were splinted and approximated will now be appreciated. It will require considerable pulling to free the single layer of gauze from the granulations and some bleeding will occur. The wound is then irrigated with normal saline. The grafts now being well united, are covered with a single layer of radium silk and top-dressed as before. This dressing including the silk may also be changed as frequently as desired without injury to the grafts. The granulations cannot attach themselves to the smooth, closely woven silk and it flattens the granulation on a level with the grafts, making a very smooth surface. It is surprising how rapidly the epithelium spreads beneath the silk and in a few days the wound is completely healed.

Although I have never used this technic with any but the Ollier-Thiersch grafts, it is evident that it must work equally well with the "small deep grafts" from the very fact that the granulations between the grafts will become attached to the single layer of gauze.

Twenty-three cases have been treated by this method which includes those treated by Dr. Jacob Manting. The two cases in which the greatest difficulties and poorest results were encountered are here reported. The remaining twenty-one cases were most satisfactory and practically all the grafts took.

Doctor Manting's case, a man, age thirty-six; a third-degree burn of the left side of the body, involving almost the entire upper extremity, a large burn over the pectoralis major muscle and the outer and posterior aspect of the leg. The grafting was performed in two sittings. The upper extremity and chest at the first, with perfect results. Ten days later the leg was grafted. The patient was a very nervous individual and hard to control. Through his restlessness he injured the grafts, resulting in only 60 per cent. take.

Second case, a boy, age fourteen; a third-degree burn involving one-half of the right thigh and three-fourths of the leg. This burn occurred one year ago. Two attempts to graft the area were previously made resulting in a complete failure. The exuberant granulations were shaved off with a razor under anæsthesia; the base presented dense scar tissue. Wet dressings were applied for two days, after which the entire area was grafted. Practically all the grafts took except an area two inches in diameter on the calf. This failure was attributed to the impaired circulation of the part due to the scar tissue at the base of the granulations. This area was again grafted several months later; the graft took but in a few months an ulcer appeared over the same area.

DANIEL J. LEITHAUSER
Detroit, Mich.

OSTEOMA OF THE FRONTAL BONE

OSTEOMATA of the bones of the skull are relatively common, and, unless situated so as to cause symptoms from encroaching upon surrounding structures, are of little moment. Many overlie meningiomas and are really hyperostoses secondary to the underlying tumor. When osteomata occur about the orbit or frontal sinus they may cause serious local disturbances and intracranial complications. This is especially true of ethmoid and frontal sinus osteomata in which their removal becomes imperative. The frontal sinus



FIG. 1.—Appearance of tumor showing scar of former operation.

and ethmoid osteomata have been discussed fully by Cushing, Armitage, and others. The case I wish to present is of a different type, originating in the frontal bone and later encroaching upon and deforming the orbit and frontal sinus.

CASE.—C. H., a school-girl, sixteen years of age, came to me January 29, 1931. Family history, negative. Menses began at fifteen and regular. Always well except attacks of headaches all life. Present illness began about four years ago. Patient came home from school with very severe frontal headache and obtained no relief from medication. A slight elevation on right side of the forehead was noticed for the first time. No soreness or tenderness observed. One week later surgeon chiseled off lump. Headaches relieved until about six months ago when they returned. Previous to this had noticed lump again. Headaches have persisted and very severe past six weeks.

OSTEOMA OF FRONTAL BONE

During past six months unable to open right eye completely and eyeball will not turn upwards. Each attack of headache confined patient to bed for two or three days at a time. No visual disturbance except that caused by inability to look upwards with right eye.

Examination revealed a bulging in right frontal region projecting three-fourths of an inch above the surrounding scalp and about two and one-half inches in diameter each way. The supra-orbital ridge was pushed downwards, narrowing the orbital cavity. The bulging and thickening involved the outer two-thirds of the supra-orbital ridge and extended upwards for two and one-half inches. Laterally it extended to within one-half inch of the great wing of the sphenoid and involved the external angular process of the frontal bone. Medially it extended to within one-half inch of the sagittal suture and deformed the lateral wall of the right frontal sinus. There was a scar over the middle of the tumor. (Fig. 1.) The neurological examination revealed right orbit limited in motion upwards to the horizontal position. Ptosis right lid, apparently mechanical and not due to nerve paralysis. Fundi and fields negative. No other changes in the nervous system. X-rays of the head revealed a tumor of the right frontal bone involving the outer part of the orbit and the lower two and one-half inches of the outer part of the frontal bone. (Fig. 2.) The blood Wassermann was negative.

Operation under avertin anesthesia February 3, 1931. All Saints Hospital. A horse-shoe flap of scalp was turned downwards. A grayish-colored bone-tumor was revealed. (Fig. 3.) The line of demarcation between tumor and normal bone could be distinctly seen. The tumor was surrounded with trephine openings and the openings connected with the De Villbiss. The supra-orbital ridge was preserved and the main mass of bony tumor lifted out. The exposed dura was normal, as well as the inner table. The excessive bone production appeared to be limited to the diploe. The inner table was not deformed. The orbital plate was

thickened in its anterior part and this portion was removed. The outer shell of the supra-orbital ridge was left as a bridge. (Fig. 4.) All demonstrable tumor tissue was removed with the rongeur and curette. The lateral and frontal walls of the right frontal sinus were removed. The mucous membrane was left intact and would balloon out with each respiration. The flap was replaced, leaving a rather large bone defect. Convalescence was uneventful and the wound healed *per primam*. The headaches have not recurred and there is only slight limitation of motion of the right orbit. The ptosis has partially disappeared.

The growth evidently originated in the frontal bone above the supra-orbital ridge. It gradually extended in all directions until it involved almost the entire supra-orbital ridge, the orbital plate of the frontal bone, the lateral and frontal walls of the right frontal sinus and extended downwards to include the external angular process of the frontal bone. The orbital cavity had been very much narrowed from above downwards so that the orbit was crowded and the upward rotation limited. The most disagreeable



FIG. 2.—Lateral film showing projection of tumor.

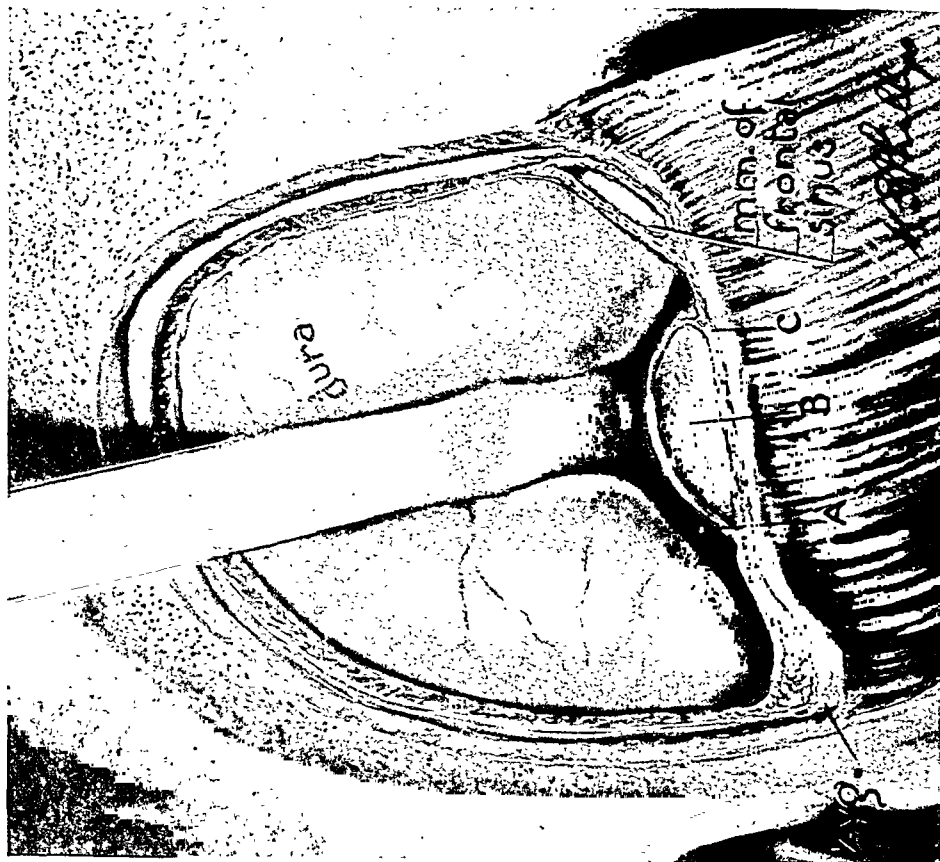


FIG. 4.—Appearance after removal of tumor.

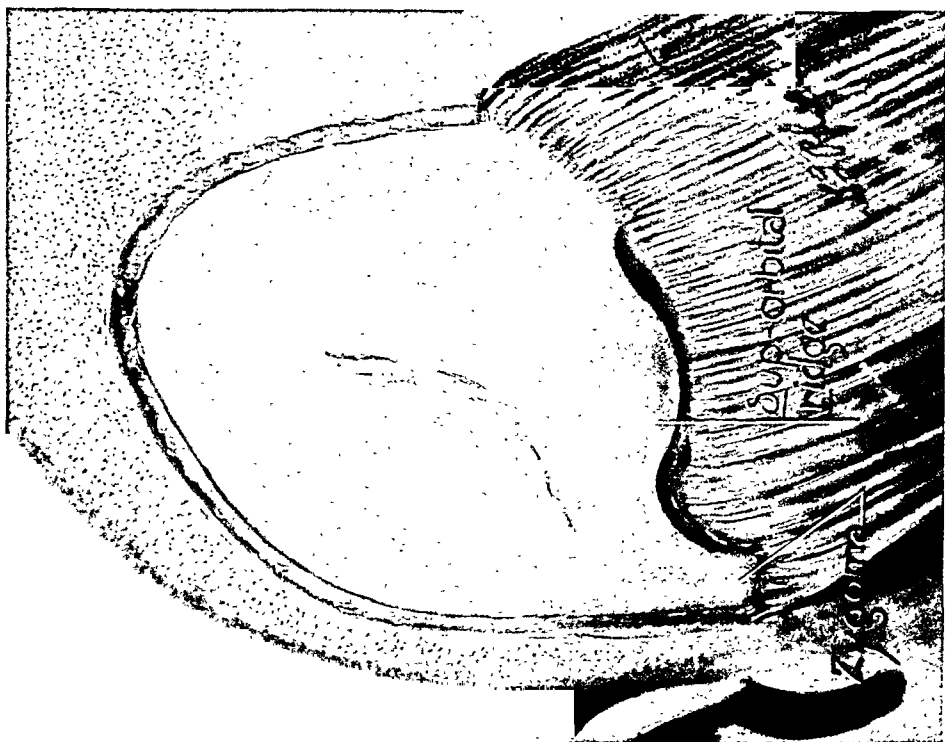


FIG. 3.—Tumor after turning down flap of scalp.

OSTEOMA OF FRONTAL BONE

feature was the constant pain. At operation the consistency of the osteoma was softer than normal bone, had a granular appearance and could be removed with a bone curette except the inner and outer tables, which were as hard as normal bone. The microscopical description after decalcification follows. (Dr. Wm. J. McLean, pathologist.) Specimen consists of a portion of frontal bone measuring six by four, five by two centimetres. External surface exhibits an eroded depression two centimetres in diameter. This discoid piece of bone is uniform in consistency and possesses an eburnated type of hardness. Grossly, it is healthy compact bone throughout, except at a superficial eroded



FIG. 5.—Appearance ten days after operation.

area in depression noted above. Cross-sections were taken through bone and decalcified. Microsections show the inner table of circumferential lamellæ to be well preserved. The outer table is roughened and ragged; for the most part it is composed of degenerated sclerotic tissue and partially dissolved fragments of osteoid trabeculæ. The spongy bone or diploe shows neoplastic bone generation. The osteoid trabeculæ are thrown down in a very orderly fashion and the lamellæ are completely differentiated into dense cancellous and compact bone formation. The lacunæ or spaces are filled with a connective-tissue type of osteogenic tissue. Marrow tissue has the appearance of being almost completely smothered out. The osteoblasts are numerous and maintain an orderly arrangement. Capillaries in lacunæ are congested. This picture indicated neoplastic

bone generation of the diffuse type. However, the differentiation into compact and dense cancellous bone is complete. This may be considered a form of neoplastic bone production midway between the benign classical osteomata on the one hand and osteosarcoma on the other. It possesses a tendency towards progressive extension but will not metastasize. *Diagnosis.*—Diffuse osteomatosis. (Virchow.)

The youth of the patient and the comparative rapidity of the growth makes one fear a recurrence, although all demonstrable tumor was removed. This patient would have undoubtedly been beyond surgical relief in another year or two because the tumor was almost beyond surgical accessible regions at the time of operation. Eighteen months have elapsed since the operation with no signs of recurrence and the patient is still free of pain and has almost a normal upward rotation of the orbit. The removal of so large an area left a large bony defect. (Fig. 5.) It is planned to insert a celluloid plate at a later date for cosmetic effect.

WILLIAM O. OTT, M.D.

Fort Worth, Texas.

A PRACTICAL APPLICATION OF WOLFF'S LAW AS TO THE INTERNAL STRUCTURE OF BONE *

DURING the past century three very important discoveries have been made in connection with the structure of normal bone under normal conditions of weight bearing and muscle pull and its variation from the normal under abnormal conditions of weight bearing and muscle pull.

During the first part of the nineteenth century, Bourguery, Vard, Vymann, Engel, and others observed the fact that the spongiosa of every part of every normal adult bone has a definite anatomical structure. Thus the

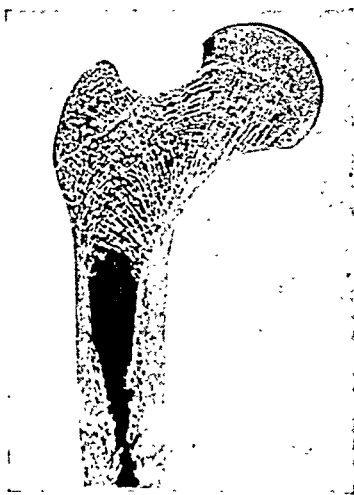


FIG. 1.

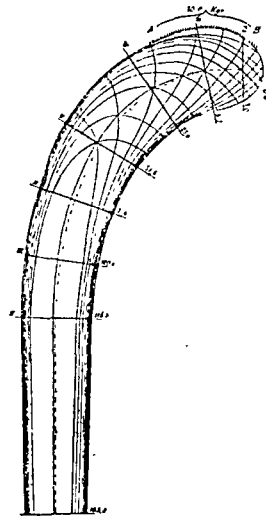


FIG. 2.

trabecular arrangement of all normal adult femora are exactly alike and this is true of all corresponding bones of the human skeleton.

In 1867 the mathematician, Cullman, in studying some anatomical preparations of Herman von Meyers, made the further discovery that: "The course of the trabeculae of the spongiosa agrees with the so-called stress trajectories of graphical statics."

* Read before the North Central Illinois Medical Association, December 6, 1932.

Thus, Figure 1, taken from Hoffa's *Lehrbuch der Orthopädischen Chirurgie*, represents a sagittal section of the upper end of the femur. Figure 2, taken from the same author, represents a crane shaped like the upper end of a femur, showing the lines of maximum stress and strain to which such a crane would be exposed in supporting the weight of an average torso of say about 150 pounds. A glance at these two figures immediately reveals the fact that the trabeculae of the femur are arranged exactly as are the lines of major stress and strain in Cullman's drawing, based on his mathematical calculations. In other words, the architecture of the femur is so arranged as to offer the greatest resistance to normal weight bearing and muscle pull by the utilization of the least possible bony material.

Later Wolff discovered the fact that the internal structure of the bone will adjust itself to any new weight-bearing requirements to which it may be exposed. Thus, if a faulty union occurs after a fracture the lines of greatest stress and strain will necessarily be altered and in consequence thereof the trabeculae rearrange themselves so as to meet the new conditions of stress and strain, just as soon as the limb begins to function with the bone in this abnormal shape. A sagittal section of such a deformed bone will show the trabeculae arranged differently from a corresponding normal bone.

The following is a literal translation of Wolff's Law as given by Hoffa.

Just as normal bones possess an internal structure in conformity with the so-called stress trajectories of graphical statics so can the architecture of bones whose forms have undergone changes due to pathological processes be predicted with mathematical certainty.

The foregoing is a recapitulation of generally known and universally accepted facts in regard to the internal structure of normal bone and of the changes which occur in the internal structure of a bone when the stresses and strains to which it is subjected vary from the normal.

My object in briefly restating these facts is to show their relation to an observation I made some time ago in reference to the internal structure of the upper end of a femur during the healing process of a fracture of the hip. Not only is this observation of scientific interest but of real practical value because it gives us a hint as to the best method of treating such fractures. Several years ago I saw a sagittal section of the upper end of a femur in which a fracture of the neck had occurred about six months previously and which had been treated by the Whitman method. The thing that attracted my attention immediately was the fact that the trabeculae were not deposited normally but instead were arranged criss-cross and in every possible plane. Previously, in examining X-ray plates of cases treated by the Maxwell-Ruth method this abnormal arrangement of the trabeculae had not attracted my attention. In going back to the X-ray plates of the cases treated by the Maxwell-Ruth method and inspecting them more critically, I made the observation that in each instance examined I found the trabeculae all laid down normally.

BRIEF COMMUNICATIONS

A number of case histories could be given and the röntgenograms could be exhibited to illustrate the above statement but it seems more desirable to give one case in detail particularly as we were able to secure a number of excellent stereopticon films which show the trabeculation with unusual clearness.

Mr. C. C., Case 20145, a well-developed male, aged thirty-nine, was admitted to the service of my associate, Dr. A. T. Lundgren, at the Augustana hospital January 26, 1930, with a mesial fracture of the anatomical neck of the femur. Twelve hours after admission the fracture was reduced and put up according to the Maxwell-Ruth method of extension and internal rotation. Stereopticon films taken March 15 show the fragments in fair apposition. April 5, or ten weeks after the fracture had occurred, stereopticon films were again taken and Doctor Beilin, the röntgenologist, made the following report:

Stereoscopic films taken of the left hip region reveal that the line of fracture is considerably obliterated and is occupied by new bone formation. There is no marked irregular distortion of the trabeculae at the site of fracture, which indicates that the lamellae of new bone are considerably laid down in their normal direction and plan. The shaft is only slightly displaced upward, approximately one-half inch.

Radiographically the findings are consistent with union at the left hip region. The marked absence of irregular distortion of the bone grain at the site of fracture indicates that the lamellae of new bone which were laid down are consistent with the normal pattern of architecture.

At this time the extension was removed and the following day a plaster-of-Paris spica was applied from the umbilicus to an inch above the left knee. Three days later the patient was allowed to walk with crutches and with a high sole on the good foot. Discharged from hospital eleven weeks after admission. July 19, or twenty-five weeks after the fracture occurred, the spica and high sole were removed and the patient allowed to walk with a cane. On that date following notation was made: July 19, 1930, patient lying flat on back, both lower extremities lying on table apparently exactly alike. No eversion of either foot. Right anterior superior spine to right internal malleolus $38\frac{1}{2}$ inches. Left anterior superior spine to left internal malleolus 38 inches. Left knee flexes to 95 degrees passively and to 90 degrees actively. Thigh flexed on abdomen to 135 degrees. Abduction 45 degrees.

This case is typical of all the cases treated by this method and is reported because it illustrates the fact that if a fracture extremity is placed in as nearly normal a condition as to weight bearing and muscle pull as is possible under the circumstances the bone salts will be deposited correctly in the first instance, thus saving the necessity of reabsorption and redeposition. That this will save much energy, time, and expense to the patient must be self evident. In addition it will almost surely prevent ununiting fractures, one of the most common and distressing complications of fractures of the hip.

EDWARD H. OCHSNER,
Chicago, Ill.

EDITORIAL ADDRESS

The office of the Editor of the *Annals of Surgery* is located at 386 Park Street, Upper Montclair, New Jersey. All contributions for publication, Books for Review, and Exchanges should be sent to this address.

Remittances for Subscriptions and Advertising and all business communications should be addressed to the

ANNALS OF SURGERY
227-231 South Sixth Street
Philadelphia, Penna.

ANNALS *of* SURGERY

Vol. XCVII

MARCH, 1933

No. 3

DEAD BONE GRAFTS TO REPAIR SKULL DEFECTS

By BORIS E. PANKRATIEV, M.D.

OF KAZAN, RUSSIA

FROM THE SURGICAL DEPARTMENT OF THE RIJSEKSTOWN HOSPITAL

RECENTLY, I have had the opportunity of applying dead human bone for cranioplastic purposes in four cases operated upon by me personally. In the first instance, I made use of a piece of skull bone taken from my museum collection, which bone had been that of a boy upon whom I had operated for a skull lesion before his death. In the three other cases I took the bone from cadavers.

The first successful attempt at cranioplasty with bones, according to Grekov's data, was made by Jacob von Mackren (Moiasson—Job van Meekren), who succeeded as early as 1670 in repairing, by using a piece of dog's bone, a defect in the skull of a Russian who had been hit on the head by a sword. It is interesting to note that the bone had to be removed because the Church held that implanting a bone from a beast into the human body was marring God's image in man.

In 1882 MacEwen and in 1891 Ricard transplanted the bones of dogs into human skulls; the former used the occipital bone, the latter the hip bone. Other attempts in transplanting dead bones into the human skull include the work of Laksh from a goose's skull, and Kuttner from an apes. Westermann was the first to apply a boiled bone in a complicated fracture of the hip. He removed a bone fragment eight centimetres long by three and one-half centimetres wide, boiled it, and transplanted it back into the damaged point. Martens, Bunge and others also approve this method of using a boiled bone. Abrajánov prepared a bone transplant by dissolving the fat by means of ether, and boiling it, making it soft and spongy and capable of being cut with a scissors. Barth and Grekov used bits of red-hot bone. Senn decalcified bones.

Later MacEwen suggested leaving damaged skull bones where they were and after trepanning, replacing the fragments as a mosaic. Dobrotvorsky used to cover a damaged area with pieces of rib. There have been other similar attempts. However, the sum total of such experiments is not great. Cranioplasty with dead human bones is not as yet a widespread practice in surgery. Different authors deal with the question in various ways. Axhausen, Petrov, Lexer and others consider it more expedient to use a live autotransplant with a periosteum. On the other hand, such authors as Barth, Turner, Zeller and others consider it possible to obtain good results with a dead bone by heterotransplanting.

Personally, I am not an opponent of the first group of surgeons and I find the use of the autotransplant quite expedient, but in some cases I am ready to second the opinion of the latter authors. The preliminary operation of taking the material from a live man may offer a certain interest for the surgeon, but it is highly disagreeable for the patient. In taking an autotransplant from the patient himself, or from another person, one may weaken a bone to such an extent that a fracture may occur at the site where the transplant was removed.

At times large transplants have to be taken for the skull which have to correspond exactly to the shape and size of the defect, and such transplants from the autoplasic point of view cannot be obtained. In one of my cases I had to cover a skull defect fifteen by ten centimetres. One can only obtain a transplant of such dimensions from the skull of a cadaver. With this plastic method one has the advantage of being able to choose the right size of the transplant, and also to prepare in advance the shape required; thus no valuable time is lost during the operation in its preparation. It is not simple, however, to accomplish this technic properly. These cases require meticulous care, as any pressure on the brain of an ill-adapted transplant may cause various undesirable complications.

As to the question of regeneration of the bones, according to Bielogorsdsky, transplanation of foreign dead bone raises the level of calcium in the blood, which fact must be taken into consideration. In the regenerative process the osteoblasts make use of the heightened level of calcium in the blood for a more rapid replacement of the defects of the skull. As in place of the resorption of the transplant, fresh bone is being formed, thus filling the existing defects, which would practically never close without plastic intervention—particularly if they are of any considerable size. Because of this fact, as pointed out by Bergmann, that bones of the skull *per se* practically have a limited regeneration ability.

We have to consider a point made by Grekov, that the edges of the transplant should come in close contact with the diploe of the defects in the human skull. For this purpose, before transplanting the bone, the diploe should be denuded and the old periosteal scar should be carefully cut out. When inserting the transplant between the dura mater and the periosteum or even bone between their fragments, by putting the transplant in touch with the diploe, we facilitate the regenerative process. In such cases the bone transplant prevents the periosteum from adhering to the dura mater.

The regenerative process in the skull bones proceeds very slowly. In very large transplants, when we have to cover large skull defects, even if one does not obtain a complete regeneration of the whole transplant, at any rate there is obtained an inner prothesis quite suitable in its chemical and morphological structure to the normal human bones.

CASE I.—(No. 986.) Tushukova, T. S., aged sixteen years, a Russian girl, was brought to the Surgical Department of the Riazsktown hospital November 3, 1928, with a complicated skull fracture, sustained by being struck on the head with a stone. Patient unconscious part of the time; profuse hæmorrhage. There was present a

DEAD BONE GRAFTS IN SKULL DEFECTS

lacerated skin wound five centimetres long in the middle line of the occipital bone. Probing disclosed a fracture of the skull at the site of the skin wound and a depression of the fragments, otherwise negative. Temperature, 38.6°C .; pulse, accelerated.

Operation.—The skull was immediately trephined, fragments of the bone were extracted until a skull defect formed three centimetres by two centimetres large. In order to cover this defect a dead skull bone was transplanted, which had been carefully sterilized first by boiling in a 2 per cent. solution of sodium bicarbonate and then in a physiological solution of 0.8 per cent. of sodium chloride.

The site of the lesion had been previously prepared by removing with a Luiner's bone extractor some of the inner plate of the skull of the patient, causing the outer plate to hang above the inner one. Having thus prepared the cavity the transplant was inserted behind the artificially formed prominences at the top and bottom of the outer plates of the skull; which remained fixed without even any retention sutures through the inner cerebral pressure upon the dura mater supporting the adjusted transplant. The hæmorrhage from the dura mater and from the diploe ceased at once. As a child's bone thinner than that of the patient had been transplanted, a hollow appeared on the site of the skull defect. An incision was made on the hip, and a piece of adipose tissue was transplanted in order to cover the skull hollow at the site of the wound. The lacerated edges of the skin wound on the head were cut out at the time of making this graft. The post-operative course of the patient was quite normal. The wound healed by primary intention—except the two sutures which pulled through because of the tension, which was remedied by secondary tension suture. The fat transplant adhered firmly.

When the patient was discharged from the hospital five weeks after the accident and operation, there had been a complete repair of the original skull, and complete anatomical restoration, both of bone and of soft tissues. She has been examined twice during the year and a half since the operation. The skull defect has been completely covered with dense bone tissue. She feels well, has married, cares for her home, and helps with farm work.

CASE II.—(No. 943.) Yerin, V. S., a Russian peasant, aged twenty-three years, unmarried, was brought to the Surgical Department November 12, 1929, on account of traumatic epilepsy and a skull defect. The condition was due to his having been hit eight years before with a horse shoe, causing a fracture of the fore part of the skull. His hearing had been greatly impaired by the injury; two and a half years after the trauma he began having epileptic attacks. These occurred two or three times a month. The patient was of medium build, and well nourished. On the forehead there was a scar adhering to the underlying tissues and slanting downwards from left to right, about seven centimetres in length and a disfiguring defect of the frontal bone six centimetres long. Pulsation of the brain was visible at the site of injury. The patient had an idiotic expression; answered questions with great difficulty; suffered from vertigo and was taciturn and melancholic. In addition to his deafness, there was a tingling in his ears. Behavior calm, except during epileptic seizures, otherwise negative.

Operation.—On November 21 the skull was trephined under a local anaesthesia of 0.5 per cent. novocaine solution. The scar was cut out; the depressed bone fragments were extracted, as well as a fragment of the frontal bone about 2 centimetres by one-half centimetre in size, which had not adhered to the surrounding bone scar, but which was pressing directly upon the brain tissue; several other similar separate small bone débris were also extracted. In order to facilitate the regeneration of the transplant, the edges of the skull defect were refreshed so as to denude the diploe. The skull defect, having the shape of a triangle seven centimetres in its base and about four centimetres high, was covered with a transplant taken from a cadaver, as in the previous case, at the morgue. The bone, after having been thoroughly sterilized was fastened to the edges of the skull defect by three wire sutures. The edges of the transplant had been properly adjusted to the previously denuded diploe and covered on the edges by fragments of the periosteum. The skin wound was closed by catgut sutures without drainage.

The post-operative course was normal. The operation produced a very rapid effect. Within two days the headaches ceased; the patient's expression became more natural; he answered questions readily and became less taciturn, and his hearing improved considerably. However, shortly before leaving the hospital on December 20, he had one attack of epilepsy. When discharged he felt well; the cosmetic effect was excellent.

May 24, 1930, the patient was examined; the transplant was found to be in good condition; the edges were smooth, and had apparently blended with the skull bones, which indicated that the regenerative process was going on normally. At home the patient had begun to perform different tasks about the house. After leaving the hospital, for a time he was free from epileptic attacks, but during an attack of influenza he had had slight convulsions, which ceased after his recovery. The patient, at the time of examination, had become more normal mentally, was less taciturn; his vertigo and headaches had ceased, and his hearing was much improved. He could perform different kinds of work in the house and even in the field. The skull defect was covered by a solid bone tissue, evidently newly formed, and partly by the transplant.

CASE III.—(No. 957.) Lotarava, E. S., a Russian peasant girl, unmarried, fourteen years old, was brought to the Surgical Department November 16, 1929, on account of an osteosarcoma of the skull.

The patient's mother informed us that her daughter was born with a small bone tumor on her head. Recently a rapid growth of the tumor had been observed. At the same time the patient began to suffer from headaches. The patient was of normal stature, of regular constitution, and well nourished. In the area of the frontal bone, starting from the inner edge of the left eyebrow, a dense prominent bone tumor was present, in shape resembling a cock's comb, crossing the entire frontal bone—it extended over to both temporal bones, widening in this region. The general extent of the tumor in length from the before backwards, was fifteen centimetres, its width in the area of the temporal being ten centimetres. The swelling, as mentioned, was dense and prominent, the skin covering it above was not normally mobile; otherwise normal.

Operation.—Under a general ether anæsthesia the skull was trephined, and a bone tumor fifteen by ten centimetres was removed. The tumor was prominent not only externally, but impinged on the inner surface of the skull as well and caused severe headaches by its intracranial pressure. The enormous defect formed by the extraction of the osteosarcoma was covered with a transplant of a suitable size and shape taken from a cadaver's skull. The edges of the transplant were shaped and smoothed with a file, then sterilized. It was fastened in by means of four wire sutures and covered with the periosteum. In two regions where the transplant had not come in touch with the dura mater, where it had fallen in as a result of tumor protuberances, in order to avoid a dead space, pieces of fat taken from the patient's hip were inserted. Wound closed without drainage.

Immediately after post-operative there was a cessation of respiration, followed quickly by cardiac failure, notwithstanding adequate stimulation, resuscitation was not effected. However, the anatomical restoration of the defect, after the tumor was extracted, was excellent.

CASE IV.—(No. 347.) Simanin, M. I., five months old, a Russian peasant's daughter, was brought to the Surgical Department on account of cerebral hernia April 28, 1930. The mother said that the child was born with a tumor near the right eye, about the size of a pigeon's egg. As the infant grew, the tumor increased in size. The mother had three other children, all normal. Before entering the hospital, the child's entire body became covered with a scrofulous eruption. No pathological symptoms of heredity.

For its age the child was of normal stature, of regular development, slightly under-nourished. On the face, between the right eye and the bridge of the nose, there was a growth the size of a hen's egg; it was tense. It covered a part of the right eye as well as the nostril, and obstructed the child's breathing. When the child cried, the swelling

DEAD BONE GRAFTS IN SKULL DEFECTS

became more tense and compact and prominent. The hairy part of the head presented a scrofulous eruption. The submaxillary and inguinal or lymphatic glands could be palpated. *Diagnosis.*—Cerebral hernia.

Operation.—May 8, 1939, under ether anesthesia, an oblique incision was made on the protuberant surface downward. The hernial pouch was opened, discharging a large quantity of transparent cerebral liquid. In examining the inner surface of the protrusion, a bone defect one-half centimetre was found on the right base of the skull. The edges of this bone defect were limited by the frontal and the ethmoid bones, and by the anterior portion of the upper jaw-bone as well. The edges of the defect were refreshed and a piece of bone removed from the tibia of a cadaver, thoroughly sterilized by boiling first in a 2 per cent. sodium bichloride solution and next in 0.8 per cent. physiological salt solution, and inserted into the defect. This oblong piece of bone corresponding in size to the skull defect was fastened to the frontal edge of the defect, which served to stop the escape of the cerebral fluid.

The hernial sac, its inner surface consisting of an extension of the hard cerebral membrane, was removed, as well as the redundant skin, and the wound closed without drainage by a double catgut suture.

The post-operative course was without any complications. There was no post-operative vomiting. The wound healed by primary intention. Twenty days after the operation the child was allowed to leave the hospital, and was referred to the pediatrician for treatment of the scrofula.

COMMENTS.—Here are presented four histories of skull repair by means of dead human bones. In the first case, cranioplasty was performed on account of a recent complicated skull fracture, with both an immediate and a final good result.

In the second case, cranioplasty was used to cover an old defect causing traumatic epilepsy, and a disfiguring scar on the forehead. The result was favorable; observation of the patient continued for six months after the operation, showed permanent improvement.

In the third case, it was used where there was an enormous skull defect fifteen by ten centimetres in size, after the extraction of an osteosarcoma of the skull case. The patient unfortunately died from the effects of anesthesia. The operation proceeded smoothly, offering no difficulties, but the patient's unexpected inability to withstand the anæsthetic prevents my reporting a case which I believe would have shown an excellent surgical result.

In the fourth case, a congenital defect of a child's skull and cerebral hernia were successfully treated. Considering the weakened organism here dealt with, the case shows the technical correctness and expediency of the surgical method of bone transplantation.

The method is applicable both to fresh, non-infected wounds and also to old bone defects with scar tissue. In case infection may be anticipated, applying cranioplasty seems inexpedient. The later suppuration of the wound would probably necessitate the extraction of the transplant, preventing a favorable result. Such defects as those formed after extracting bone skull tumors, congenital cerebral hernia, may be considered as amenable to cranioplasty.

I wish to emphasize the importance of the suggestion made by Grekov

concerning the careful application of the transplant to the denuded diploe, to promote the regenerative process. The covering of the transplant by the periosteum contributes to the improvement of the covering of the defect as well, aided to a certain degree by the hard cerebral membrane. In operating we have to spare the periosteum as well as the dura mater, bearing in mind that in general the regenerative processes of the skull bones are very limited.

In addition to the strictest aseptic measures, the following details were carefully observed in these operations. Applying a bone transplant of exact size and shape, and the fastening of it by wire sutures. All of these measures are to be strictly observed, to prevent the possibility of post-operative meningitis as well as acute purulent encephalitis. In spite of the manifest advantages of replacing skull defects with dead human skull bone, this method of repair is not yet widespread. The method has many advantages, for the transplant is of material approaching very closely, by its chemical and morphological structure, the skull bones receiving the transplant.

BIBLIOGRAPHY

- Abrajanov: Transplanting and Plugging of Bones. Petersburg, 1900.
 Grekov: Materials Concerning the Question of Skull Bone Defects and Their Treatment. (Experimental Clinical Investigation.) Petersburg, 1901.
 Bergmann, Bruns and Mikulicz: Handbuch der praktischen Chirurgie. Kopfchirurgie. Band I.
 Petrov: Free Bone Plastic Surgery. Petersburg, 1913.
 Tihov: Private Surgery, vol. i, Petrograd, 1915.
 Rasumovsky: Recent Data of the Skull; Cerebral Surgery, Russian Surgery, vol. ii, 1916.
 Rojdestvensky: Materials Concerning the Question of Bone Defects of the Skull and Their Treatment. Kazan, 1917.
 Zeller: Bone Transplanting. (Surgical Review.) Surgery, Leningrad, 1926.
 Bielogorsdsky: Modern Surgery. Revised by V. A. Oppel. Book 2, 1926.
 Turner: Economy Régime Consisting in Borrowing Human Bones for the Purpose of Transplanting. Work of the Nineteenth Meeting of Russian Surgeons. Leningrad, 1927.
 Turner: Biology and Mechanics of Bone Transplanting. Modern Surgery Review. vol. ii, Book 3, 1927.
 Nemiloi: Free Organ and Tissue Transplanting. Leningrad, 1927.
 Bier, Braun and Kummel: Chirurgische Operationlehre.

STUDIES ON ACUTE CRANIAL AND INTRACRANIAL INJURIES

BY ELISHA STEPHENS GURDJIAN, M.D.

OF DETROIT, MICH.

FROM THE DEPARTMENT OF NEURO-SURGERY, RECEIVING HOSPITAL

CRANIAL and intracranial injuries are at present an important surgical problem, and it is probable that they will increase in importance for many years. In the present paper I propose to discuss conclusions from a study of cases entering the Receiving Hospital for an eighteen-month period (January, 1930, to July, 1931). During this period the position of this institution has been rather unique in that practically all cases picked up by the police ambulance in the Detroit area were brought here. It is evident, therefore, that this study represents all types of cases, of different social states and of all ages. A certain number left the hospital and were transferred to other places, but in the majority only after they were out of danger. A certain number of the transferred group were also followed up in this study. Several of the fatal cases were autopsied at the Coroner's office, to which the author is indebted. I also thank Dr. E. T. Olsen and the members of the surgical staff for coöperation and advice.

In the entire series of 718 cases 475 were proven to have skull fracture (ray, inspection and autopsy). Two hundred and forty-six showed clinical evidences and spinal-fluid findings indicative of brain dysfunction and damage. It is not sufficient to discuss only cases with skull fracture without due consideration being given those patients who, even though they were not demonstrated to have a fracture, actually suffered brain dysfunction. Among some of the latter group the clinical evidences may be just as severe as those with serious skull injuries. If, on one hand, one discussed cases of proven skull fracture only, he would of necessity omit many patients with severe brain injury due to trauma. On the other hand, a consideration of cases of brain injury alone would necessitate the omission from one's series of many cases of proven skull fracture with no evidences of brain dysfunction or injury. It is, therefore, better to consider these two groups of cases together for a better understanding and treatment of patients. From a statistical standpoint, the respective groups should be properly evaluated. It is true that even though a case of skull fracture may not have associated brain injury his group presents a poorer prognosis than the group with no fracture. Skull fracture is a serious condition and should be considered so. The low mortality rates appearing in the literature lately do not do justice to this fact, for under the guise of skull fracture many cases of minor head injuries are also considered, thus bringing the mortality down. However, it is true that skull-fracture mortality today should be lower than ten or fifteen years ago, for with the refinement of

X-ray technic and insistence on the part of hospital authorities to ray practically all cases of head injury, many asymptomatic cases of fracture are added to one's series. Years ago such cases were undoubtedly considered under the classification of "concussion" and were probably never suspected of having a fractured skull.

Before going into a discussion of my thesis I think it advisable to say a few words about X-rays in skull-fracture work. An increasing number of skull injuries in late years has made X-ray examination of such cases an important procedure in most hospitals. Medico-legal aspects also have made it important to use rays routinely in all cases of suspected injury to the head. At present X-ray technic is far enough advanced to enable an experienced röntgenologist to demonstrate pathology in the greatest majority of cases. It is a well-known fact that a certain number of cases diagnosed as alcoholics, demented individuals, *etc.*, have been properly classified by the demonstration of fracture by ray.

The use of Röntgen-rays in cases of suspected skull fracture, to my mind, has been slightly overemphasized from a prognostic standpoint. When one realizes that the demonstration of fracture and its extent is another laboratory aid, its utilization as such is only in conjunction with other clinical and laboratory findings. As emphasized by several investigators it is the associated brain damage which is all-important in cases of fracture of the skull.

In this institution suspected cases are rayed within twelve hours after entrance into the hospital if their condition permits. It is true that in a certain number one gathers invaluable data from the ray examination which may alter the course of treatment. The location of the fracture may be important in some cases of middle meningeal hæmorrhage. Its position along with other clinical data may enable one to make a diagnosis of orbital frontal lacerations (see page 350). The type of fracture, *i.e.*, fissured, diastatic, depressed or stellate, is important in some cases at least from a surgical standpoint.

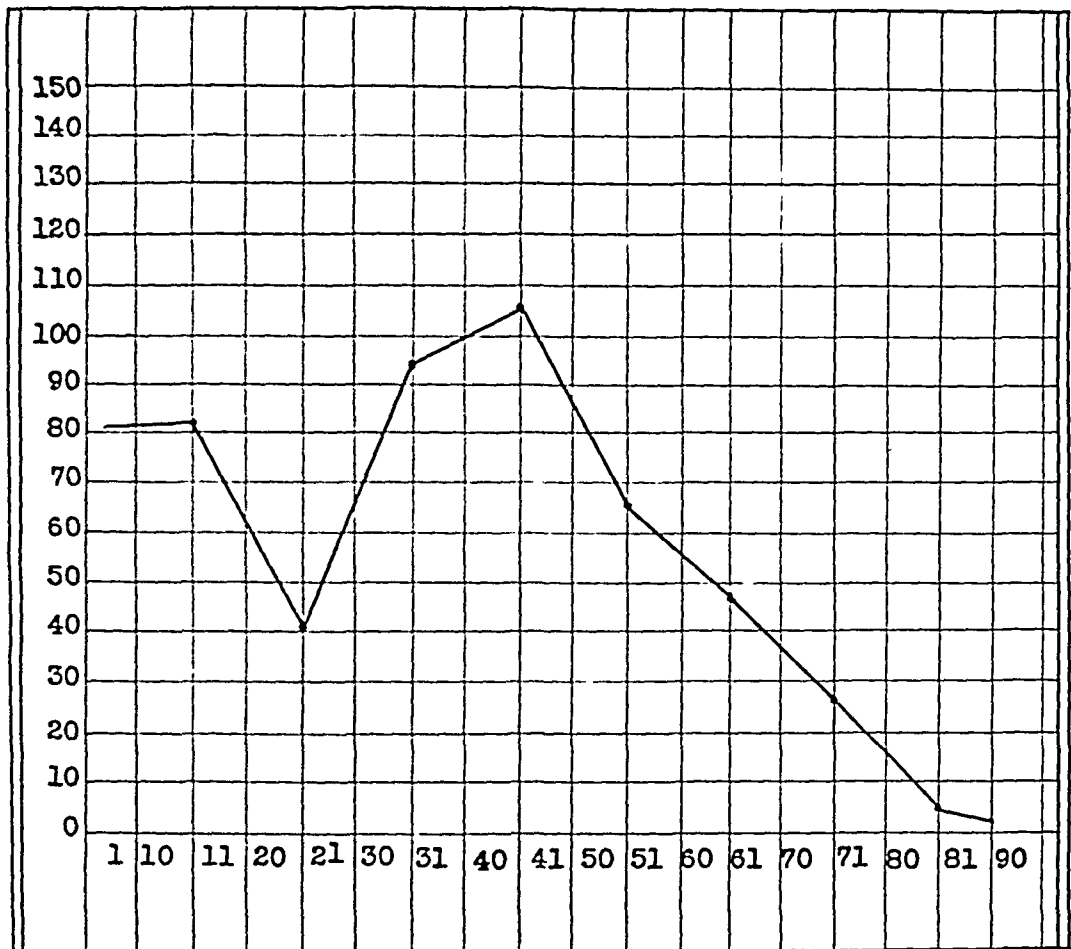
At the Receiving Hospital (R. J. Kenning, Röntgenologist) a rapid technic is used in order to secure diagnostic röntgenograms. Approximately seventy kilowatts and forty milliamperes at twenty-four inches with double screen has been found to be efficient in the demonstration of fracture in the greatest majority of the cases. A number of patients are usually confused and irritable so that question of immobilization is of paramount importance and this rapid technic has enabled the department to get good films whereas with the longer technic of bucky diaphragm it would be rather difficult. Routinely A.P., P.A. and right and left lateral plates are procured. In some cases, when the patient's condition permits, stereo-bucky plates are also procured. Where a fracture is suspected in the mastoid area, such as in cases of bleeding from the ear, the patients are rayed using the usual right and left mastoid positions.

Middle meningeal groove markings should not be difficult to recognize

CRANIAL AND INTRACRANIAL INJURIES

and should not be mistaken for fractures. Suture lines are not usually confusing. One has to be careful in diagnosing diastatic fractures and make sure that his technic is quite perfect. It is important to keep in mind that fine lines of fracture may not appear on the plate in the presence of poor focusing on the pathology. The clinician can help the röntgenologist a great deal by giving him as much of the clinical data as possible because by so doing the latter may be able to demonstrate better any fracture lines by focusing directly on the suspected area. In some cases it will be necessary to re-ray the patient for the demonstration of the fracture. I recall

TABLE I



This is to show the age distribution in cases of skull fracture in the present study. Note that between the ages of ten and twenty the number decreases.

one case where the patient was rayed three times and finally the mastoid exposure showed a fracture line which was suspected and yet had not been previously demonstrated by rays.

Distribution and Type of Fracture.—Table II shows the distribution of fractures in the series. I have divided the skull into thirds, namely, the anterior third, extending as far back as the fronto-parietal sutures, including the anterior fossa; the middle third, extending from the fronto-parietal sutures to the occipito-parietal, including the middle fossa; and the posterior third, made up of the occipital vault and the posterior fossa. It seems to me

that this classification is much simpler, although I realize that it is only based on topography and, therefore, may not do justice to certain principles of the genesis of skull fractures. It is also true that in a certain number the fracture may involve the length or circumference of the vault. It is seen that middle-third fractures clinically are the most frequent (Table II), although in autopsy material (LeCount and Apfelbach) posterior third fractures are the most numerous. Such a discrepancy speaks of the greater mortality with fractures of the posterior third of the skull. Fractures involving the anterior third of the skull may be subdivided into those of the

TABLE II
Analysis of 475 Cases of Positive Skull Fractures

| ANTERIOR THIRD OF SKULL | | | | | MIDDLE THIRD OF SKULL | | | | POSTERIOR THIRD OF SKULL | | | |
|----------------------------|------|-----------|-----------|-----------|--------------------------|------|-----------|-----------|-----------------------------|------|-----------|-----------|
| 137 CASES OR 26.5% | | | | | 237 CASES OR 46.02% | | | | 141 CASES OR 27.4% | | | |
| RIGHT | LEFT | F.S. | BASE | DEPRESSED | RIGHT | LEFT | BASE | DEPRESSED | RIGHT | LEFT | O.M. | DEPRESSED |
| 60 | 77 | 29 | 37 | 30 | 120 | 117 | 50 | 32 | 67 | 74 | 26 | 7 |
| | | OR | OR | OR | | | OR | OR | | | OR | OR |
| | | 21.1 % | 27.1 % | 21.8 % | | | 21.1 % | 13.5 % | | | 18.4 % | 4.9 % |

This is to show the position of fracture in the series. Fractures involving the middle third of the skull are most numerous. There were fourteen cases with multiple fractures in this group study. F.S., frontal sinus; O.M., fractures involving foramen magnum.

right and the left side, those involving the frontal sinus, those involving the anterior fossa and those showing depressions. A comparison with the middle-third fractures shows that base involvement and depressions are more common in the anterior third of the skull. It is probably true, however, that most of the isolated, short middle-fossa fractures are missed by ray. Fractures in the posterior third of the skull have been sub-divided into those involving the right and the left side, those extending into the foramen magnum, and those showing depressions. It is to be noted that depressions in the posterior third of the skull are infrequent.

CRANIAL AND INTRACRANIAL INJURIES

Depressed and Compound Depressed Fractures.—As shown in Table III, there were sixty-nine cases of depressed and compound depressed fractures in the series. Among those with simple depressions a certain number did not show any clinical evidences of brain damage. It appears from the table that depressions occur most frequently in the middle third of the skull, although on a percentage basis they are more common in the anterior third. Undoubtedly, one reason for this is the fact that frontal sinus depressions are also included in the anterior third of the skull in the above classification. Depressions in the posterior third are infrequent and apparently serious

TABLE III
Analysis of 69 Cases of Depressed Fracture

| BRAIN INJURY | | | | DISTRIBUTION OF FRACTURES | | | | | | DEPRESSED COMPOUND FRACTURES | | TREATMENT | | RESULTS | |
|--------------|--------|----------|--------|----------------------------|------|--------------------------|------|-----------------------------|------|------------------------------------|-----------------|-----------|-----------------|--------------------|------|
| NONE | SLIGHT | DEFINITE | SEVERE | ANTERIOR THIRD SKULL | | MIDDLE THIRD SKULL | | POSTERIOR THIRD SKULL | | 14 CASES | | OPERATED | NOT OPERATED | 69 CASES TOTAL | |
| 13 | 17 | 18 | 21 | 30 | | 32 | | 7 | | OPERATED | NOT OPERATED | 34 | 35 | RECOVERED | DIED |
| | | | | RECOVERED | DIED | RECOVERED | DIED | RECOVERED | DIED | 10 | 4 | RECOVERED | DIED | RECOVERED | DIED |
| | | | | 27 | 6 | 25 | 8 | 3 | 4 | RECOVERED | DIED | 24 | 10 | 27 | 8 |
| | | | | | | | | | | 8 | 2 | 0 | 4 | MORTALITY 26.1% | |

An analysis of depressed fractures in the series. Note that posterior third depressions are infrequent and very serious. Thirty in this group had little or no evidences of brain injury.

as concerns prognosis. There were fourteen cases of compound depression of which ten were operated upon and four were in too serious a condition for surgical intervention. It has been the policy in this institution to take care of compound depressions as soon as the patient's condition permits. In simple depressions with no evidences of brain damage it is left to the patient to decide whether or not he would care to have the depression corrected. A great many in this group refuse operation and a majority of those who were followed up apparently were getting along without any sequelæ. (Several have been followed up for eighteen months or more.) The follow-up studies of Glaser, Ireland, and others in cases of depressed fractures are instructive. In this connection the presence of chronic in-

fections, such as lues, may be a factor in the production of the undesirable sequelæ seen in some of the cases. Simple depressions which are operated on are treated according to standard technic. (See Treatment.)

Frontal Sinus Fractures.—The subject of frontal sinus fractures has been considered by several writers. The contributions of Teachenor, Peet, Andruss, and others are helpful and worthy of careful study. In a previous contribution in collaboration with Dr. H. K. Shawan, I reported a series of 125 sinus fractures. The incidence in this series is about the same as previously reported. The results are again very gratifying with two deaths among twenty-nine such cases. There was no meningitis in this series. Table IV is an analysis of the sinus fractures. It may be seen that the incidence of clinical evidences of brain injury is low. There were two cases of compound fracture which were operated on with good results. In both

TABLE IV
Analysis of 29 Cases of Frontal Sinus Fractures

| DISCHARGE FROM NOSE | | | BRAIN INJURY | | | | DISTRIBUTION OF FRACTURES | | | | | | EXTENSION OF SINUS FRACTURES | | | OPERATIONS | | RESULT | | | |
|---------------------|-----------|----------------|--------------|--------|----------|---------|---------------------------|-----------|----------|----------|-----------|----------|------------------------------|-----------|----------|-------------|-----------|---------------------|-----------|-----------|------|
| NONE | EPISTAXIS | C.S. DISCHARGE | NONE | SLIGHT | DEFINITE | SERIOUS | RIGHT | | | LEFT | | | BI-LATERAL | | | INTO VERTEX | INTO BASE | OUTER WALL OF SINUS | 2 | RECOVERED | DIED |
| | | | | | | | 9 CASES | | | 14 CASES | | | 7 CASES | | | | | | | | |
| | | | | | | | SIMPLE | DEPRESSED | COMPOUND | SIMPLE | DEPRESSED | COMPOUND | SIMPLE | DEPRESSED | COMPOUND | | | | | | |
| 18 | 11 | 0 | 8 | 12 | 8 | 1 | 8 | 1 | 0 | 9 | 5 | 1 | 4 | 3 | 1 | 25 | 16 | 7 | RECOVERED | DIED | |
| | | | | | | | | | | | | | | | | | | | 2 | 0 | |
| | | | | | | | | | | | | | | | | | | | 27 | 2 | |

An analysis of fractures involving the frontal sinus. A majority had little or no clinical evidences of brain damage.

a modified Killian operation was performed. They both recovered. It is of interest to note the extension of the sinus fracture into the vertex or base. In the presence of such conditions some authors have considered the cases of a compound nature insofar as the contents of the cranial cavity are concerned. They have thought it advisable to explore the sinus in order to prevent infection. It is surprising to note that most of these patients recover with conservative treatment. There were two cases of aërocele of the sinus which recovered. Two other patients had cloudy sinuses indicative of intrasinus bleeding; they also recovered. It should again be emphasized that "wholesale" operating in this region is a poor policy; first, because such operative intervention is not necessary to save the life of the patient; second, because operations in this region are followed by deformities which are a psychic problem to the patient; and, third, because any operative procedure does shock the patient and may accentuate the signs and symptoms of brain injury.

Fractures Involving the Foramen Magnum.—Fractures of the base of the skull, particularly those of the posterior third, have been considered serious. Undoubtedly, there is ample evidence to show that this assumption is correct. However, from this present study, I am led to believe that a certain number of posterior fossa fractures may be practically asymptomatic because of lack of associated brain damage. A fracture of the skull as such is of little significance; it is the associated brain injury that is important, as well as the complications caused by the fracture, such as meningitis, infection of the brain, *etc.* Posterior fossa fractures are notorious in the production of contrecoup damage to the brain. In the LeCount and Apfelbach series the incidence was 78 per cent.

Linear fractures extending into the base of the posterior third of the skull may be roughly divided into three groups: first, those passing through the more central portion of the foramen magnum; second, those passing through the more lateral portion of the foramen magnum; and, third, those passing lateral to the foramen and usually involving the jugular foramen. In my experience it has been generally true that with a more lateral fracture at the base, the brain damage has been more severe. With a fracture in close proximity to the centre of the foramen magnum a certain amount of the force causing the fracture is buffered by the elasticity of the tissues in this situation, and, therefore, this force is limited to the place where the blow was given. With a fracture more laterally placed the force behind the blow is transmitted to the general cavity of the cranium with the ensuing brain damage so common in fractures of this type. This is a mere generalization and seems to hold true at least in the present series. When the blow is severe enough to cause the foramen magnum fracture to extend through the basilar process of the occipital, the associated signs of the brain injury are undoubtedly marked.

In the present series there are twenty-six cases with occipital fractures extending into the foramen magnum. The age distribution is interesting in that six of the entire group were under ten years. In a previously recorded series such a high incidence among the younger group is also noticeable. Clinical evidences of brain injury were not present among ten, with slight evidences among another thirteen. It is true that this analysis is based on ray findings and therefore does not represent a true cross-section of cases with such fractures. It is also true, however, that in the autopsied group the occipital fractures were mostly lateral to the foramen magnum. In presenting the above paragraph or two I endeavor to show that certainly a large number of foramen magnum fractures may be practically asymptomatic and that this is more true in cases with fractures involving the more central portion of the foramen and not extending into the basilar process. Bleeding from the ears occurred more frequently with such fractures as compared with the entire series. (See Table V.)

GENERAL CLINICAL AND LABORATORY CONSIDERATIONS.—*Age Distribution.*—Among those with skull fracture the age distribution is interesting.

Between the ages of one and ten years there are a great many cases, but the number decreases between the ages of eleven to twenty, probably because in the first decade the ability to size up situations is not so well developed whereas in the second decade the young person has learned certain fundamental principles of how to protect himself against injury. From twenty on the number of cases increases. The boy now, has his car, he is just beginning to experience the novelty of getting intoxicated, *etc.* The greatest number of cases appear in the fourth decade. From this period on the number decreases due to a lower percentage of people alive in the higher denominations, and also because they are less active. Table I shows a diagrammatic representation of the age distribution in cases of skull fracture in the series.

Etiology.—By far a majority sustained fractures in automobile accidents. A history of fall was obtainable in a certain number. A few patients gave

TABLE V

Analysis of 26 Cases of Fractures Extending into the Foramen Magnum

| ETIOLOGY | | | | | AGE DISTRIBUTION | | | | | | | | BRAIN INJURY | | | | BLEEDING EARS | | | RESULT | | |
|----------|------------|------|------|--------------|------------------|----------|----------|----------|----------|----------|----------|----------|--------------|------|--------|----------|---------------|-------|------|-----------|------|-----------|
| AUTO | STREET CAR | BLOW | FALL | UNDETERMINED | UNDER 10 | UNDER 20 | UNDER 30 | UNDER 40 | UNDER 50 | UNDER 60 | UNDER 70 | UNDER 80 | UNDER 90 | NONE | SLIGHT | DEFINITE | SERIOUS | RIGHT | LEFT | BILATERAL | DIED | RECOVERED |
| 15 | 3 | 1 | 4 | 3 | 6 | 1 | 5 | 3 | 4 | 5 | 1 | 0 | 1 | 10 | 13 | 2 | 1 | 2 | 4 | 1 | 1 | 25 |

Analysis of fractures extending into the foramen magnum. A majority had little or no evidences of brain damage. A great many occurred among patients under the age of ten.

a history of direct blow on the head. A number had gunshot wounds. The majority, however, were in accidents, which may have injured any part of the body. This is important from the standpoint of treatment, for even though there may be evidence of skull injury, other parts of the body such as spinal column and cord, chest, abdomen and extremities may also be implicated. In the present series at least twenty-five deaths were caused by co-existent pathology elsewhere. A history of the accident is therefore important, in that direct blows to the head are more apt to cause local injury alone.

History of alcohol and alcoholic breath were noted among 112 of the cases under the classification of skull fracture. The mortality in this group does not present any peculiarities as compared with that of the general series. A combination of alcoholism and head injury in the beginning gives one the impression of serious prognosis. However, in a great many the picture changes within twelve to twenty-four hours. Acute alcoholism is a factor in the causation of skull fracture. After all, a normal person—barring tender age—with normal reaction time is not apt to become en-

tangled in accidents, and the majority of skull injuries are seen among those less alert and more or less partially incapacitated individuals. It may be an error of refraction in some, poor mentality and lowered brain function in others, chronic alcoholic degeneration, *etc.* I think it is true that under the influence of alcohol many a person is hurt who, under normal conditions, would probably be free of accidents.

Temperature, Pulse, Respirations and Blood-pressure.—In cases of brain injury, temperature, pulse, respirations and blood-pressure should be recorded frequently and particularly changes should be observed. Alterations in these various clinical data have been the subject of careful study in the hands of several authors (Kocher, 1901; Holbrook, 1924; McClure and Crawford, 1928; McCreery and Berry, 1928; Peet, 1928; Fay, 1930; and others). In some papers I think their significance is overestimated; in others possibly it is underestimated. It is my belief that one can learn something about the patient and his general condition by studying every and all clinical findings. In some cases, as is natural, some clinical data will be found to be more important and decisive than others, but an effort to correlation is very important, and would undoubtedly be productive of better diagnoses and treatment.

Temperature.—Temperature changes are of important prognostic value. In the initial state of shock the presence of subnormal temperature and with increasing intracranial pressure and traumatic encephalitis the increase in temperature are important to observe. If a temperature (rectal) is above 105°, and attributable to brain damage and increased intracranial pressure, it is, as a rule, of grave prognostic value. I have seen very few among them recover, and autopsy in the majority of the fatal cases did not show any pathology corrigible by any present-day procedure. I think in some cases increase in temperature, not attributable to brain damage, may be an expression of serum disease, in that all these cases of head injury with lacerations are given tetanus antitoxin. High temperature readings in children are not so serious as in adults, a fact stressed by Ireland.

Pulse and respirations.—It is unfortunate that true pictures of pulse and respirations as in cases of ideal increased intracranial pressure do not obtain frequently in patients with brain injury. Low pulse and increasing respirations were seen rarely, at least insofar as the series presented is concerned. However, in a certain number of cases this manifestation does occur, and, if so, it should be given its relative value in the treatment of the patient. Increase in respirations seems to be a more sensitive sign of increase in intracranial pressure and traumatic encephalitis. In order to properly evaluate such clinical data one should emphasize the importance of frequent readings for in the absence of such procedure changes are not perceived, and if so they may not be considered so significant.

Blood-pressure.—Much has been said concerning the significance of blood-pressure determinations in cases of craniocerebral injury. Rising blood-pressure, if present, is undoubtedly due to a medullary stimulation

However, in the majority of cases, blood-pressure determinations frequently made are of no significance as a measure of degree of intracranial pressure. This is essentially the conclusion arrived at by Holbrook, 924; McCreery and Berry, 1928; Fay, 1930; and others. Particularly is this brought out when one compares spinal-fluid pressure determinations with blood-pressure. In the majority of the cases studied the discrepancy is very marked. It is true that one should insist upon blood-pressure determinations in every case of cerebral injury, but one should also be prepared to discard readings in most cases as of any clinical value whatever. Blood-pressure findings tell us of general condition of the patient as to whether or not he is in shock, *etc.* More important than changes in blood-pressure, the state of pulse pressure seems to me of great prognostic significance. Particularly when the pulse pressure is equal to the systolic is a grave outcome to be expected. I have seen eleven cases with blood-pressure determinations comparable to 120/0; 100/0; *etc.*, where the mortality was over 90 per cent. In the present series there were two such cases. The physiological explanation of this phenomenon is probably as follows: With too much irritation of the vasoconstrictor centre a paralysis of the same ensues, with consequent peripheral vasodilation, hence lack of diastolic pressure. In such cases, then, the only pressure found in the arteries is that imparted by the action of the heart. In conclusion, I may say that blood-pressure determinations in craniocerebral injuries are found to be valueless, as an index of increased intracranial pressure, in the greatest majority of cases.

DISCHARGE FROM BODY ORIFICES.—Bleeding from body orifices is a common manifestation in cases of craniocerebral injury. It must be emphasized that the same etiological factor may be operative in the damage to other parts of the body even though the cranial bones and contents may be implicated. For instance, in one case of head injury there was rupture of the bladder, in another there was a rupture of the kidney. One had severe hæmorrhage from the vagina on a traumatic basis. The most common orifices from which bleeding may occur, however, are the ears, the nose and the mouth. In the next few paragraphs I shall consider these various complications rather briefly for they are well known and studied entities.

Discharge from the Ears.—Many contributions discuss this phase of the work. (Besley, 1918; Stewart, 1921; Vance, 1927; Davis, 1928; McCreery and Berry, 1928; and others.) Vance finds that middle-ear-infection was the most common etiological factor in meningitis due to trauma. In Table VI I have analyzed the cases with discharge from the ear. One hundred twenty-nine patients had bleeding, cerebrospinal-fluid discharge or a combination of both. The mortality from unilateral discharge in this group is lower than in my previous presentation. (Gurdjian, 1932.) The mortality from bilateral bleeding is about the same as before. There were three cases of otitis media and two cases of mastoiditis; the latter were treated conservatively and they recovered. Facial paralysis as a complication of aural bleeding occurred in about 11 per cent. of the cases. A majority of

CRANIAL AND INTRACRANIAL INJURIES

these recovered sufficiently to close the eye within two weeks after the onset. Most of them had functional recovery within two months. In two cases of unilateral facial paralysis I know the condition persisted over six months. In two cases there was bilateral facial paralysis, one in a child five years of age. The typical expressionless face with inability to close the eyes and pucker the mouth were seen. He was much better within three months, more so in the upper half of the face. The other case of bilateral facial palsy died in the hospital. They had bleeding from both ears. Particularly in the beginning there is a definite difference in the ability to taste in the two halves of the anterior two-thirds of the tongue in these cases. This seems to disappear as the facial musculature returns to normalcy.

The X-ray findings are again commendable. A high percentage of posi-

TABLE VI
Analysis of 129 Cases of Bleeding from the Ear

| RIGHT EAR | | | | LEFT EAR | | | | BILATERAL | | | | COMPLICATIONS | | | | | | X-RAY FINDINGS | | | | | | | | |
|-----------|--------------|-------|--------------|-----------|--------------|------|------|-----------|-------------------------|------|----------|-------------------------|-----------------------|--------------------------|------------------|---------------------------------|--------------------------------|---|---|----|----|----|---|----|----|----|
| 51 CASES | | | | 49 CASES | | | | 29 CASES | | | | MENINGITIS | OTITIS MEDIA | MASTOIDITIS | FACIAL PARALYSIS | RAYED CASES UNILATERAL BLEEDING | RAYED CASES BILATERAL BLEEDING | SITE OF FRACTURE IN RELATION TO AURAL BLEED | | | | | | | | |
| REC. | DIED | REC. | DIED | REC. | DIED | | | | | | | | | | | | | | | | | | | | | |
| 35 | 16 | 34 | 15 | 9 | 20 | 2 | 3 | 2 | Unilateral Bilateral | 84 | 16 | ANTERIOR THIRD OF SKULL | MIDDLE THIRD OF SKULL | POSTERIOR THIRD OF SKULL | | | | | | | | | | | | |
| Blood | C. S. Disch. | Blood | C. S. Disch. | Blood | C. S. Disch. | Rec. | Died | Rec. | | Died | Positive | | | | Negative | Positive | Negative | | | | | | | | | |
| 35 | 0 | 15 | 1 | 28 | 4 | 12 | 2 | 9 | 0 | 18 | 1 | 1 | 1 | 3 | 0 | 2 | 0 | 12 | 2 | 73 | 11 | 15 | 1 | 15 | 48 | 29 |
| MORTALITY | | | | MORTALITY | | | | MORTALITY | | | | | | | | | | POSITIVE WITH UNILATERAL BLEEDING | | | | | | | | |
| 31.3% | | | | 30.6% | | | | 68.9% | | | | | | | | | | 87% | | | | | | | | |

Analysis of bleeding or cerebrospinal-fluid leakage from the ear. Note the X-ray findings and the distribution of fracture in these cases. Fully 55 per cent. had fractures in the mastoid region either extending into the posterior third or the middle third of the skull.

tive by ray fractures are noted among those with unilateral aural bleeding. Furthermore, it is also to be emphasized that the fracture may not be in the middle third of the skull. A certain number had fractures in the anterior and posterior thirds of the skull. This is corroborated by some of the autopsy findings where in a case with bleeding from the ear there was no fracture in close proximity to the petrous bone of the same side. It illustrates the fact that aural bleeding is just as much an index of severity of blow as it is an argument for an adjacent fracture.

In this group of aural discharge there were two cases of meningitis. One died and the other recovered following treatment by repeated lumbar punctures. In the latter a strep organism was isolated which had the cultural characteristics of Koch-Weeks bacillus. There were eight cases of cerebrospinal-fluid discharge from the ear and none developed meningitis. One

had clear fluid draining for about five days; he was in the hospital for about two months and was unconscious or disoriented for about forty days. He left the institution fully recovered and when seen about three months after discharge he was still in good condition.

In the majority, a few days following the accident, hearing is quite within normal limits, with the exception of a slight discrepancy between bone conduction and air conduction, the latter being impaired. In a certain number, annoying tinnitus is experienced, which usually disappears within two months. In this series there were no cases of complete deafness in the surviving group. Thirteen complained of tinnitus and poor hearing on the affected side which subsided rather quickly. Excellent papers have been written on the subject of ear changes following head injuries by Brünner, 1925; Linthicum and Rand, 1931; Swift, 1931; and others. Particularly Linthicum and Rand give a full account of neurological changes in post-traumatic cases. Accordingly, equilibratory complaints are common and they are attributed to a mixed central- and end-organ damage. They state that in some of these cases vestibular tests may give results similar to those obtained in cases of typical cerebellopontine-angle tumor.

The treatment in cases with aural bleeding is conservative, as was brought out in my previous communication. Undue and unnecessary examinations of the ear are avoided. If the bleeding has stopped, the ear is left alone. If there is still some discharge, a mastoid dressing is applied after cleansing the external ear and a portion of the external canal with some antiseptic solution. In the absence of complaints and unexplainable clinical course I pay no attention to the ear. In the presence of a complicating facial paralysis, the affected side of the face may be splinted by using adhesive straps with a view to elevate the angle of the mouth and suggest light massage of the face by the coöperative patient. In the majority this is not necessary, however, for beginning return of function is evidenced by the patient's ability to close the eye better. In one severe case of facial palsy I thought it advisable to keep the upper lid down with adhesive in order to do away with corneal complications.

Bleeding from the Nose.—This complication was present among 24 per cent. of the group with fracture of the skull. Four cases had cerebrospinal rhinorrhœa. The latter complication is at times difficult to recognize because of the associated bleeding. In one case the rhinorrhœa persisted for about a week with the patient doing well; then rather suddenly the patient developed evidences of meningitis. Autopsy showed a fine fracture about one centimetre in length along the roof of the sphenoid sinus, about one centimetre from the optic foramen on the right. There was very little organization at the site of fracture. It seems to me it would have been practically impossible to reach this region extradurally as Peet suggests in cases of cerebrospinal rhinorrhœa. When the fracture is over the paranasal sinuses, particularly the ethmoids and sphenoids, one should also keep in mind the fact that the roof of these spaces may be of very thin bone

and therefore easily crushed by the dissecting instruments and thus make matters worse. It seems that operative procedures to curb the incidence of meningitis in such cases have many drawbacks and that it would be ideal to have some prophylactic serum measure to prevent meningeal involvement. In some cases the bleeding is so profuse from the nose that measures have to be thought of to prevent exsanguination. In such cases we have resorted to packing the nostrils. However, in the majority the bleeding stops within a short time after the accident.

Bloody or cerebrospinal discharge from the nose is a serious manifestation in cases of skull fracture. Meningitis in this series occurred more frequently among those with bloody discharge from the nose. There were three such cases. As stated above, it would be brilliant work if some prophylactic measure in the form of serum treatment were discovered to curb the incidence of meningitis in such cases for operative prophylaxis is too severe and would expose to danger altogether too many lives in order to save a very few, if any. Patients with this complication are asked to refrain from blowing the nose. No intranasal douches are used. In the presence of cerebrospinal fluid discharge the question of a frontal flap operation with a view to repair the area of damage is kept in mind.

Vomiting.—Vomiting is a common occurrence, particularly within the first few hours after the accident. One hundred thirteen among those with proven fracture had this complication (21 per cent.). Occasionally it is bloody; if so frequently is this caused by bleeding from the nose discharging posteriorly and therefore being swallowed. On the other hand, one must not overlook the fact that bloody vomiting may denote internal injuries, or injuries to the palate or pharynx. In a certain number of cases vomiting is undoubtedly an evidence of increased intracranial pressure. Particularly is this true among those where it is a late manifestation occurring several hours or days after the accident. Children are more frequent sufferers of this complication, as also shown by Beekman and Ireland. Particularly in adults vomiting subsides rather quickly and it is not a constant finding in cases of increasing intracranial pressure due to trauma.

Urinary Incontinence.—Incontinence of urine is seen quite frequently in patients with severe shock and those with severe brain injury. There were forty-one recorded cases among those with proven fracture (7 per cent.). With amelioration of the patient's condition normal evacuation ensues. It is important in cases with urinary disturbances to be sure that the condition is of a cerebral origin rather than spinal. In three patients there was overflow incontinence due to an associated injury to the spinal cord.

OCULAR AND EXTRA-OCULAR MANIFESTATIONS.—Head injuries are frequently associated with ocular and extra-ocular changes. Contusions, subcutaneous hæmorrhages in the lids, and subconjunctival hæmorrhages are common manifestations. Occasionally the swelling is so marked as to simulate proptosis. Genuine cases of proptosis may also occur, as was true in this series in two patients. One had bilateral chemosis, and proptosis

with a septic temperature, and diagnosis of cavernous sinus thrombosis was made. In another case the patient had a definite proptosis in the left eye with the pupil slightly more dilated on the side of the lesion. Manometric studies in this case revealed that unilateral jugular compression on the left caused no change in spinal-fluid pressure, while on the right a rise of 100 millimetres was noted. It was thought that this patient also suffered from thrombotic condition involving the left cavernous sinus region.

There has been much written concerning pupillary inequality in cases of skull fracture. McCreery and Berry in a study of 512 cases noted forty-one with unequal pupils with thirty-six deaths. Blakesley in a series of 610 cases found 121 with unequal pupils with fifty-three deaths. When the dilated pupil was fixed the prognosis was less favorable. Some have advocated operation in presence of a dilated pupil. (Davis.) It must be emphasized that patients may have unequal pupils before the accident. In this series three patients with this condition had lues, and the inequality was a direct result of the latter disease. There were sixty-one cases of unequal pupils in this group study. Of these thirty-five recovered and several among them had no associated evidences of brain injury. Of the thirty-five only ten were operated on. The dilated pupil is usually on the side of the lesion. Holman and Scott, Rand and others feel that the dilated pupil is always on the side of the lesion, although I am sure this does not obtain in every case. It should also be emphasized that massive hæmorrhage in the brain may not be accompanied by inequality. This was true in several of the autopsy group. Pupillary inequalities may appear and disappear in the course of several hours. At times they are less marked under the action of a bright light. The cause of inequality of pupils is not well known. If there is cerebral representation of pupillary reaction it is possible that with injury to such a region there may be a partial paralysis of the corticotectal fibres associated with the central part of the third nucleus, and with partial paralysis of the latter and overactivity of the sympathetic innervation, a dilated pupil may ensue. It must be remembered, however, that a dilated pupil may denote a peripheral paralysis of the third nerve. If so, there should be associated outward rotation of the eyeball, and with amelioration of the patient, a definite ptosis of the lid. This is particularly true in some cases of middle meningeal hæmorrhage. Elsewhere I have discussed the fact that with an enlarging clot at the base of the middle fossa the contents of the superior orbital fissure may be compressed with consequent paresis of extra-ocular nerves, particularly the oculomotor nerve.

An absence of reaction to light is a serious manifestation, as well brought out by several authors. Stewart notes that in fifty-three cases with dilated and fixed pupils the outcome was fatal. In the McCreery and Berry series there were 168 cases of fixed pupils with 128 deaths. Blakeslee reports fifty-five widely dilated and fixed pupils with fifty-two deaths. However, some of these cases do recover and a hopeless prognosis should not be given on this point alone. Marked dilatation of the pupils is not so serious a sign

CRANIAL AND INTRACRANIAL INJURIES

in my opinion, particularly if observed soon after the accident; it may be an expression of shock. In these investigations it is important to note the time between accident and such clinical observations. If observed soon after the accident such findings are probably not as serious as when seen several hours afterwards. It is also to be emphasized that to depend on just one clinical finding alone may at times be embarrassing. As a matter of fact, in some of these cases of serious craniocerebral injury, one may prognosticate the case accurately irrespective of pupillary findings.

It is rather difficult to make a diagnosis of extra-ocular palsy in an unconscious, uncoöperative patient. Soon after the accident it is a common occurrence to find the eyes rolled upward, to one side or the other, and in



FIG. 1.



FIG. 2.

FIG. 1.—Third-nerve paralysis due to middle meningeal hemorrhage. He recovered complete function of this nerve including reaction to light and accommodation of the pupil.

FIG. 2.—Internal strabismus of the right eye (sixth-nerve palsy) with peripheral seventh-nerve paralysis on the same side. The palpebral commissure is wider on the right and the angle of the mouth does not rise as far up as on the left. Patient had fracture involving middle third of the skull.

some cases one sees coarse nystagmoid movements. However, in the absence of conjugate deviation, or the presence of unilateral mal-position, the possibility of an extra-ocular paralysis should be kept in mind. As the patients get better it is easy to note such a paralysis. In this series there were thirteen cases of extra-ocular dysfunction, six had third-nerve and seven had sixth-nerve palsy. In two cases there was thought to be an associated fourth-nerve paralysis due to the fact that in the presence of an oculomotor palsy the eyeball turned only outward instead of out and down. This is rather a coarse method of diagnosing trochlear dysfunction. The accompanying figures show some of these changes. Of particular interest

is Fig. 2, where the patient evidently has a sixth-nerve and a peripheral seventh-nerve paralysis on the same side. Third-nerve palsy was most frequently seen in middle meningeal hæmorrhage. They all recovered completely within four months after the accident. In the latter pupillary reaction to light and accommodation returned. It is possible for the sixth nerve to be injured in the superior orbital fissure, but in this position it is better protected than the third and fourth nerves because of its more peripheral position. In such a case, however, one should see more than sixth-nerve dysfunction. The condition should simulate more the superior orbital fissure syndrome by the implication of the ophthalmic division of the trigeminal nerve or the third nerve, or the fourth nerve, or a combination of all.

TABLE VII
Analysis of Ocular and Extra-ocular Changes in the Series

| UNILATERAL BLINDNESS | | COMPLETE OCULOMOTOR PALSY | | COMPLETE 6TH NERVE PALSY | | PROPTOSIS WITH SINUS THROMBOSIS | | UNEQUAL PUPIL | |
|--|---|---------------------------------|------|--------------------------------|------|---------------------------------------|------|------------------|-----------------|
| 3 CASES | | 6 CASES | | 7 CASES | | 2 CASES | | 61 CASES | |
| OPHTHALMOSCOPIC EXAMINATION NEGATIVE | 1 | REC. | DIED | REC. | DIED | REC. | DIED | REC. | DIED |
| | | 5 | 1 | 6 | 1 | 1 | 1 | 35 | 26 |
| | | | | | | | | OPERATED | NOT OPERATED |
| | 2 | | | | | | | 10 | 25 |
| | | | | | | | | 4 | 22 |

An analysis of the ocular and extra-ocular changes in the series. Note that a great many cases with unequal pupils recover on conservative treatment.

It is probably true that in the majority of cases sixth-nerve palsy is due to an involvement of the nerve in its course through the cranial cavity. The two cases I have been able to follow up in this series still have the internal strabismus due to sixth-nerve involvement (ten and fourteen months respectively). Three others have regained practically complete function.

In three cases there was complete blindness. (Table VII.) Two showed no injury to the retina and other contents of the eyeball on ophthalmoscopic examination. In one there were hæmorrhages in the vitreous and he could perceive light about the third week after entrance. The mechanism of blindness in cases where the eyeball is found to be normal is difficult to explain. It is possible to have a fracture in the region of the optic foramen with impact against the nerve and consequent blindness. This, however, could not be severe enough to cause a tear of or pressure against the ophthalmic artery which accompanies the nerve, for examination of the

CRANIAL AND INTRACRANIAL INJURIES

retina does not show any changes in vascularity of the region soon after the accident. It is also possible to have hæmorrhages in the sheath of the optic nerve with consequent pressure neuritis. Although at first the retina is negative in the course of about three months the nerve head is practically completely atrophic in appearance. In some cases of unilateral blindness it may be worth while to expose the optic region intracranially in order to remove any pieces of bone that may be pressing against the optic nerve in its course through the foramen.

Ophthalmoscopic examination is an important adjunct to our clinical methods in cases of head injury. However, its significance as a measure of degree of intracranial pressure is overestimated according to my findings. Choking of the discs is very infrequent, certainly within the first twenty-four hours. Engorgement of veins as indicative of increasing intracranial pressure is not definite enough a sign to be worthy of consideration. The same degree of engorgement is seen quite frequently in the normal in-

TABLE VIII
Analysis of 138 Cases of Death in the Series

| TIME OF DEATH | | | | | | BLEEDING EARS | | | CONVULSIONS | | | OTHER INJURIES | | | | INFECTIONS | | | |
|---------------|--------------|---------------|---------------|---------------|------|---------------|------|------|-------------|-------------|-----------------------|---------------------|----------------|--------------------------|-----------------|------------|------------|-----------|--------------|
| UNDER 3 HRS. | UNDER 6 HRS. | UNDER 12 HRS. | UNDER 24 HRS. | UNDER 48 HRS. | OVER | RIGHT | LEFT | BOTH | JACKSONIAN | GENERALIZED | DORSAL EXTENSION TYPE | FRACTURES ELSEWHERE | CHEST INJURIES | INTRA-ABDOMINAL INJURIES | SPINAL INJURIES | MENINGITIS | SEPTICEMIA | PNEUMONIA | GAS BACILLUS |
| 33 | 10 | 18 | 12 | 20 | 45 | 16 | 15 | 20 | 11 | 7 | 5 | 27 | 5 | 11 | 3 | 4 | 7 | 6 | 1 |

Analysis of cases of death in the series. Note that sixty-one cases died within twelve hours after entrance into the hospital. The résumé of injuries elsewhere in the body is instructive. Also consult text on this subject.

dividual. In a certain number of the cases I have seen hæmorrhages in the retina. A case of vitreous hæmorrhage was described in the preceding paragraph. It is my opinion that increased intracranial pressure due to brain injury does not manifest itself in the nerve head but very infrequently, certainly not within the first twenty-four hours. The absence of swelling of the nerve head has not been a criterion for intervention or non-intervention when operative treatment or spinal puncture was contemplated. Only one case of middle meningeal hæmorrhage out of six showed sufficient change in the discs to be called swelling of the same.

BLOOD STUDIES.—At the Receiving Hospital all cases of head injury have blood studies within twelve hours after entrance into the hospital. Routinely white count, red count and differential are procured. Serological studies on the blood are also used.

In cases of craniocerebral injury, particularly in the presence of cerebral damage, there is an associated increase in the white count. The majority of cases show initial counts varying between 12,000 and 18,000. There are

many who show higher counts. There seems to be a direct relation between the white count and the severity of bloody spinal fluid, *i.e.*, bruising and laceration of the cortex. Moody states that counts around 18,000 and 20,000 are suggestive of middle meningeal hæmorrhage. It is true that with extradural clot the white count ranges between 18,000 and 20,000, but there are many such counts with no associated meningeal clot. It may be stated roughly that a high count is in direct ratio with extent of brain damage with hæmorrhage. In this connection it should not be forgotten that shock and hæmorrhage elsewhere may also be productive of high counts. It would be interesting to follow up cases with initial high counts for post-traumatic sequelæ.

Serological studies showed that there were twenty-seven patients with

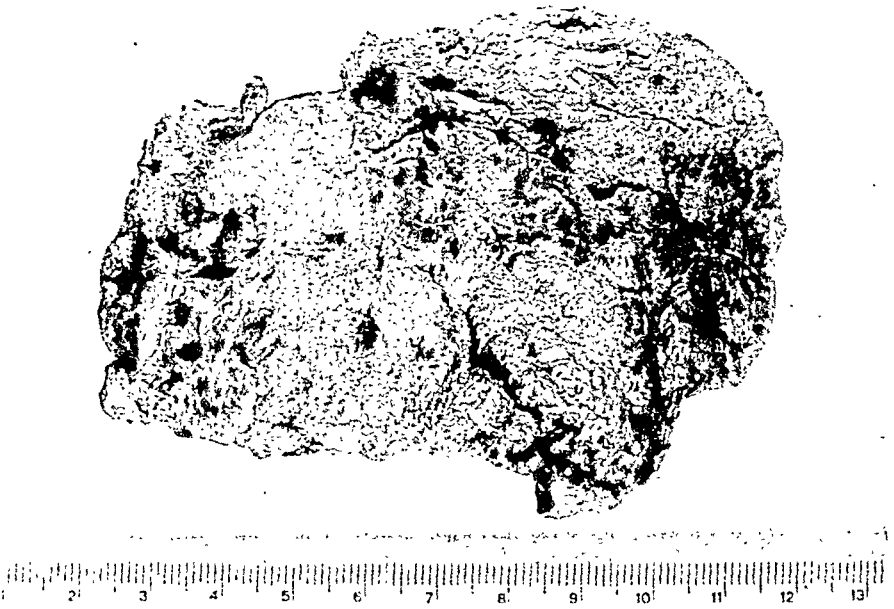


FIG. 3.—This is to show a middle meningeal clot removed at operation. It weighed eighty-five grams. It illustrates the value of osteoplastic flap in such cases, a method which affords a practically complete removal of the clot. Convalescence after osteoplastic craniotomy in these cases is much shorter.

4 plus Wassermann and Kahn. These patients may show varied neurological changes which should not be attributed to skull fracture. The association of brain damage and lues is quite unfortunate, at least in this series, in that the majority of these patients lingered on in the hospital for long periods, and some were committed to insane asylums.

NEUROLOGICAL CONSIDERATIONS.—Patients with brain injury as a rule manifest clinical changes characteristic of certain localizations. However, it must be emphasized that with an uncoöperative and unconscious patient complete neurological data are not obtainable and, therefore, it is not uncommon to miss brain pathology which is easily localizable in a coöperative patient. While the patient is in a serious state the only system which can be

tested out with accuracy is the motor system. With the amelioration of the patient's condition more data can be obtained for purposes of localization. In the next few paragraphs I propose to discuss the various neurological changes which are obtained in the present series.

Altered States of Consciousness.—Unconsciousness following trauma to the head may be caused by: first, a definite macroscopical or microscopical injury to the central nervous system; second, in the absence of the above it may be due to a change in the electrical potential of nerve cells causing dysfunction of the same (Miller); third, in some cases it may be due to vasomotor changes in the body causing anæmia of the brain as a result of migration of much blood to the splanchnic area. Miller does not think that anæmia of the brain is operative in cases of "concussion" due to blows on the head. McClure and Crawford attribute much significance to the length of the period of unconsciousness and they think that the longer a patient is unconscious the worse are the sequelæ after leaving the hospital.

In the present series there were 102 cases with proven skull fracture who gave no history of unconsciousness. The remainder of the series showed different states of altered consciousness which may roughly be classed as follows: first, those with initial unconsciousness not lasting over two hours and with some evidence of brain dysfunction not lasting over thirty-six hours; second, those with initial unconsciousness followed by definite disorientation lasting for several days; third, those in coma and most usually fatal. Of course, it is understood that a given case may show clinical signs and symptoms characteristic of any of the above groups and lapse into a state characteristic of another.

Of particular interest is the second group, where patients may remain disoriented for weeks. One case was unconscious for over forty days. There were twenty-two patients who had to be transferred to the psychopathic wards because of their mental state; all but two had bloody spinal fluid. A few among them were eventually sent to asylums. In this connection it should be stated that an associated C. N. S. lues is a serious complication. Six among the twenty-two had 4 plus Wassermann on the blood and spinal fluid. It is probably true that psychotic changes are more frequently seen among those with generalized subarachnoid hæmorrhages. The spinal fluid is usually very bloody and repeated lumbar drainage seems to have little effect on the course of their condition. However, it is surprising to note that a certain number, following a discouraging course, seem to recover practically completely.

Cranial Nerves.—In cases of acute craniocerebral injury at least some cranial nerves are frequently implicated. In one case in this series there was olfactory dysfunction due to skull fracture. Such cases have been described by several authors (Naffziger and his literature review, Swift and others). In the acute case it is difficult to test out this nerve; the associated nasal bleeding with its obstructing clots may also be a factor in mistakes in diagnosis. The second, third, fourth and sixth nerves and their dysfunctions

have already been discussed under ocular and extra-ocular changes. The fifth nerve is particularly prone to be injured in its maxillary branch with fractures that involve the upper jaw. Particularly has been the case with depressed fractures of the zygomatic arch. In such cases an anæsthesia in the distribution of the infra-orbital nerve and its ramifications is noted. The first division of the nerve may be involved in association with extra-ocular nerves as they pass through the superior orbital fissure. In one case there was anæsthesia in the ophthalmic distribution of the fifth nerve with complete extra-ocular paralysis and an associated blindness, evidently a case of the syndrome of the superior orbital fissure. The third division of the trigeminal nerve is, of course, usually associated with fractures of the lower jaw, and Dr. Lloyd Rogers, of the Department of Oral Surgery, informs me that it occurs in practically all cases where there is an associated displacement of the fragments. The seventh nerve has already been discussed in relation to blood discharge from the ear. A peripheral seventh-nerve palsy may obtain with no associated bleeding from the ear and I have seen a few such examples. In the Foster Kennedy and Wortis series peripheral facial paralysis was seen much more frequently than is evident in this group. The eighth nerve has also been discussed in relation to bloody discharge from the ear. Excellent papers on this subject are written by Brünner, Linthicum and Rand, Swift and others. According to Vance, actual nerve deafness is most probably permanent if it persists over two months. Dysfunction of the ninth, tenth, eleventh and twelfth nerves is not usually seen in civil practice. However, it is conceivable to have a fracture of the posterior third of the skull with associated involvement of any or all of these nerves. Such a case of multiple nerve lesions including the last four cranial nerves is described by SHEMELEY. These structures are more frequently involved outside of the cranial cavity by stab or bullet-wounds or tumor in the retromandibular space. Cases of this type have been described by Vernet, Villaret and Faure-Beaulieu, Sicard, Stookey, and others.

CONVULSIONS.—There were forty-six cases with convulsions in the series (6 per cent.). It is unfortunate that all cases with motor-cortex involvement do not show this complication. In the present series only ten cases in a group of forty-two showing clinical manifestations of cortical motor pathology had convulsions. Particularly the Jacksonian type is of important localizing significance. I have classified cases of convulsions into three groups on the basis of type of spell: first, those with Jacksonian epilepsy; second, those whose attacks simulate the usual epileptic fits, and third, those whose attacks are characteristic of decerebrate rigidity. For methodical purposes I will discuss each type of convulsive seizure separately. (Table IX.)

Jacksonian Attacks.—Jacksonian attacks were seen in twenty-three cases. It is interesting to note that more than 50 per cent. recovered. The attacks are characterized by localized clonic and at times tonic movements of functional groups of muscles, such as one side of the face, face and arm, an entire half of

CRANIAL AND INTRACRANIAL INJURIES

the body, *etc.* In one case I saw Jacksonian epilepsy of the tongue. From a diagnostic standpoint Jacksonian attacks are helpful, in that they most always signify injury to the corresponding motor cortex supplying the area of attack. In this clinic we feel that localized spells are cases for operative treatment when taken in conjunction with other clinical data. In the absence of corroborative clinical findings of hæmorrhage or other localized pathology we watch the patient carefully, being ready at any time to intervene surgically. In this connection it is important to mention that a certain number have attacks soon after injury who, in the course of twenty-four hours, are absolutely conscious and apparently progressing in good shape. In another group of cases Jacksonian spells have been seen as a late manifestation and in the absence of other data to justify an operative approach I have performed lumbar punctures with excellent results. However, on the whole it is true

TABLE IX
Analysis of Cases with Convulsions

| JACKSONIAN TYPE | | EPILEPTIC TYPE | | DORSAL EXTENSION TYPE | |
|-----------------|-----------|----------------|-----------|-----------------------|-----------|
| 23 CASES | | 18 CASES | | 5 CASES | |
| DIED | RECOVERED | DIED | RECOVERED | DIED | RECOVERED |
| 11 | 12 | 7 | 11 | 5 | 0 |

Analysis of cases with convulsions. Note that decerebrate rigidity type of spells are very serious as concerns prognosis.

that localized spells usually mean operative treatment, although one does not have to hurry in the absence of associated signs and symptoms indicative of localized cerebral pressure. The use of lumbar puncture in some of these cases is inestimable.

Epileptiform Attacks.—Epileptiform convulsions were seen in eighteen cases. These attacks are characterized by the usual frothing at the mouth, occasional biting of the tongue, and tonic and clonic spasms involving the entire body. A few of these cases were epileptics to start with and this possibility should always be kept in mind when observing such a spell in cases of skull fracture. I think that in most cases of generalized convulsions conservatism is the proper procedure, in the absence of localizing signs. Here also lumbar punctures are invaluable. It should be emphasized, however, that Jacksonian spells may eventuate in generalized convulsions, the latter manifestation probably being due to the associated increased intracranial pressure and traumatic encephalitis. Of eighteen cases showing this complication only seven succumbed.

Decerebrate Rigidity Type of Attacks.—I have seen five cases of convulsions characterized by tonic contraction of the entire body musculature, particularly the trunk and lower extremities, so much so that these parts of the body form an arch with convexity upward with the body in the recumbent position. The upper limbs also showed some contractures to a great extent characteristic of decerebrate rigidity. It is the sort of convulsion seen in children with chronic basal meningitis. Associated with this extreme tonic convulsion of the body musculature (dorsal extension type), some cases also showed a few clonic spasms of functional muscle groups. This type of convulsion has always been fatal in this series. They all had spinal fluid with very high blood content and evidences of bilateral pyramidal-tract irritation. I wonder if such attacks may be an expression of irritation of the brain stem due to the irritating influence of blood in the ventricular system, and associated traumatic encephalitis.

TABLE X
Some of the Focal Manifestations in the Series

| RIGHT HEMI- PLEGIA | LEFT HEMI- PLEGIA | MONOPLEGIA | | PARAPLEGIA | | TRIPLEGIA | APHASIA | CATATONIA | RESULTS | | | | CONVULSIONS |
|--------------------------|-------------------------|------------|-------|------------|-------|-----------|---------|-----------|----------|--------------|-----------|--------------|-------------|
| | | UPPER | LOWER | UPPER | LOWER | | | | DIED | | RECOVERED | | |
| | | | | | | | | | OPERATED | NON-OPERATED | OPERATED | NON-OPERATED | |
| 13 | 11 | 4 | 1 | 0 | 3 | 2 | 8 | 5 | 8 | 11 | 9 | 12 | 10 |

An analysis of some of the focal manifestations in the series. Note that a great many recover without operation.

(OTHER CORTICAL AND SUBCORTICAL MANIFESTATIONS.—Table X shows the number and type of changes recorded in the series. By far the majority showed hemiplegia. There were thirteen cases with right-sided and eleven cases with left-sided paralysis. In one case the right-sided hemiplegia was the result of hæmorrhage due to rupture of the lenticulo-striate artery in a patient fifty-four years of age. Monoplegia was seen in five cases. Lower extremity paraplegia was seen in two cases, and it was a result of tangential fractures along the vertex. Two cases had triplegia, one due to extradural clot, and the other due to a tangential fracture. Aphasia was studied in eight cases. Among these seven had the usual right-sided paresis and one had a pure aphasia associated with catatonia. Catatonic states were noted in five cases. Only ten patients in the entire group of forty-two showed irritative manifestations, *i.e.*, convulsions. Of these eight had Jacksonian epilepsy, one generalized convulsions and one spells of the dorsal extension type. In the next few paragraphs consideration will be given some of these above findings.

The Syndrome of the Superior Longitudinal Sinus.—In 1914, Holmes

and Sargent described the syndrome of the superior longitudinal sinus. They brought out the fact that tangential fractures involving the convexity of the vault near the mid-line were associated with paresis of the lower extremities with also a possible involvement of one of the upper limbs. The pathology was that of either destruction of the lower extremity centres near the mid-line from the fracture or a destruction of the blood supply from the same region due to thrombosis of the superior longitudinal sinus. Willensky, Levi-Valensi and Ezes, and others have described cases of this type occurring in civil practice. In four cases of this series such a diagnosis could be made both on clinical and pathological grounds. One which came to autopsy showed a marked rigidity of the lower limbs. There was a perforating wound passing through the superior longitudinal sinus, causing a large clot between the two hemispheres and over the corpus callosum. Another case had a depressed fracture in the interparietal region with rigidity of the lower limbs. A third case came in about six weeks after the accident with a depression in the interparietal region. He had severe sensory and motor changes in the leg and foot on the one side with some motor changes in the opposite limb. The depression was removed and soon after the patient was much better. Three months after operation he stated that he was practically normal. The fourth case was that of a middle meningeal hæmorrhage which had dissected its way between the dura and the bone over the convexity of the hemisphere, extending over the mid-line where there was a large globular mass of blood pressing against the lower extremity centres on both sides. This patient had bilateral Babinski, ankle and patellar clonus with a dilated pupil and evidence of third-nerve paralysis on the right side. It was easy to explain the clinical findings following operation and following the finding of a large blood clot across the mid-line in the posterior parietal region. The diagnosis of superior longitudinal sinus syndrome should be kept in mind in the presence of increased reflexes and rigidities involving both lower limbs. Such a conclusion may materially alter the method of treatment in the case.

Catatonic States in Skull Fractures.—Gowers discusses the possibility of catatonia following blows on the head. Kleist did much work on the relation of catatonia and aphasia and is of the opinion that catatonia may be a pyramidal dysfunction. Wilson feels that catatonia may be due to lesions of the pyramidal system. Vogt, Hoff and Schilder, Dejerine, Lewy and Urechia discuss the association of catatonic states with striatal and cerebellar diseases. In the *Journal of Nervous and Mental Diseases*, 1931, I described two cases of catatonic rigidity due to skull fracture with brain injury. I am now able to add three more cases, two in adults and one in a child four years of age. One of these patients, an adult of twenty-seven, had a fracture in the left parietal region with definite evidences of aphasia and catatonic rigidity of all four extremities. It is interesting to note that in this case following a lumbar puncture which yielded clear spinal fluid the patient instantly was capable of speech and his catatonia also disappeared, to reappear in a few hours in a milder form. The second adult was a patient of thirty-eight with

fracture particularly in the left parietal region and also crossing the mid-line and extending into the right parietal. He had a marked aphasia of the motor speech type with a very definite catatonia involving all four limbs. His catatonic condition disappeared before the aphasia which lasted in a milder form four or five weeks. This patient could be placed in the most bizarre positions with no apparent fatigue. The third case, a child of about four years of age, had no skull fracture by ray, but was unconscious for several hours following a blow on the head. He had a dissecting hematoma between the scalp and the bone which apparently filled practically the entire sub-aponeurotic space of the head. This child had definite evidences of catatonia.

The association of catatonic states with aphasia in cases of skull fracture with brain injury is outstanding. In the previous communication it was noted that such states in cases of skull fracture in association with aphasia are most probably of cortical origin. I still cling to this conclusion and, furthermore, I feel that in an unconscious patient the presence of catatonia is most probably indicative of a lesion in the left fronto-parietal region of the cortex. It is possible that with the destruction of the correlative motor centres on the left side there may be associated inability to gauge the extent of movement of a certain part in the production of a certain complex movement with consequent result of catatonic rigidities. It is also possible that with the destruction of such centres which may be located in close proximity to the speech centres there may be an inability to properly correlate the individual components of a complex movement so that when the patient has a limb placed in a certain position he has a lack of the ability of correlation of components of the complex movement of allowing that limb to go back to the normal resting state. I think catatonic states should be looked for in cases of brain injury and I am sure that in a certain number of cases they will be discovered. Further observations may enable one to prove definitely whether or not they have a localizing significance as suggested above.

The Diagnosis of Laceration of Orbital Surface of Frontal Lobes.—In a previous communication in the Archives of Neurology and Psychiatry on the subject of diagnosis of lacerations of the orbital convolutions of the frontal lobe, I brought out the fact that such lacerations may be diagnosed before death, at least in a certain number of the cases. It is true that a large majority of skull-fracture cases coming to autopsy show contrecoup lacerations in this situation. It is also true that the orbital surface of the frontal lobe is essentially a silent area except its extreme posterolateral portion, which is continuous with the lower end of the Sylvian fissure. In cases of contrecoup damage to the orbital surface of the frontal lobes there is an added damage to the tip of the temporal pole and the lower end of the Sylvian fissure by virtue of the presence of the sharp posterior margin of the lesser wing of the sphenoid bone. With involvement of the lower end of the Sylvian fissure there may be motor phenomena in the opposite half of the body particularly involving the face and possibly also the upper limb. These may be irritative in nature such as Jacksonian epilepsy of the face and upper limb or paralytic

such as cortical facial paralysis and increased tendon reflexes in the upper limb on the opposite side. It is probably true that in the absence of localized depressions pressing against the face centre, Jacksonian epilepsy of the face denotes a more extensive lesion than one involving the region of the face centre alone, particularly in cases of contrecoup damage. In such cases, given a patient in coma with bloody spinal fluid and a fracture in the posterior half of the skull, it can be assumed that the irritative or paralytic phenomena involving the face are of orbital frontal damage significance. For it is true that in cases of skull fracture with brain injury particularly with contrecoup lesions the damage is more regional in character rather than localized, such as caused by a knife, a small tumor, or a bullet. The diagnosis of such lacerations can be made in some of the cases after a careful study of the patient and after due consideration is given to every finding in the physical examination. The position of the fracture, particularly if it involves the posterior third of the skull, the spinal-fluid findings which should be bloody, and the presence of Jacksonian epilepsy of the face or also the upper limb in the absence of localized depressions over the motor centres should make one suspect such lesions. In one case with an extensive compound depression in the left frontoparietal region such lacerations were seen at operation, and the only manifestation of a motor nature the patient had was cortical facial weakness on the opposite side. This patient recovered.

Alternating Oculomotor Paralysis in Middle Meningeal Hæmorrhage.—In a certain number of cases with middle meningeal hæmorrhage there is a syndrome similar to that described by Weber and of mid-brain significance. In a previous paper appearing in the Archives of Neurology and Psychiatry I described this similarity and gave several examples. It was thought that oculomotor paralysis in these cases was due to pressure against the contents of the superior orbital fissure and the cavernous sinus. It is true that extra-ocular paralyses have previously been described in cases of middle meningeal hæmorrhage. But the association of an extra-ocular paralysis (particularly the third nerve) with contralateral paralysis of the body reminds one of Weber's syndrome. The contralateral paralysis is undoubtedly due to pressure against the motor cortex by the enlarging clot. In one case there was an associated proptosis of the affected side most probably due to sufficient pressure to cause an engorgement of veins of the orbit by virtue of pressure against the cavernous sinus. There were six cases of middle meningeal hæmorrhage diagnosed in the series, four of which showed the alternating oculomotor paralysis. Of these six, four recovered and they were all operated on. Of the fatal two one was not operated, and the other underwent surgical procedure, but he succumbed, undoubtedly to associated brain damage which the autopsy showed. In his case there was a large intracerebral clot in the temporal pole on the same side with laceration of the orbital convolutions of the frontal lobe on the opposite side. His fracture was confined to the posterior third of the skull, and apparently damaged the posterior branch of the meningeal artery. In all but one there was a history

of lucid period. With the exception of the one whose autopsy report is recorded above, they all had temperatures varying from 99° to 102°.

A word concerning the incidence of middle meningeal hæmorrhage in this series would be apropos. It is true that the incidence of middle meningeal hæmorrhage in various morgue series reported in the literature is high (Moody, Vance, McCreery and Berry, and others). Possibly this may be due to the fact that a larger number of them are picked up on streets or in homes, and therefore were unrecognized. But in hospital practice the number of middle meningeal cases is indeed small, possibly because conservatism is in vogue at the present time. In sixty-one consecutively autopsied cases in this series there were only two with middle meningeal hæmorrhage and one of these was operated on, so that the frequency of middle meningeal hæmorrhage, at least in this series, could not be very high when one also considers that in a great many of the fatal cases the pathology was evident (compound fracture, meningitis, infections in other parts of the body, lacerations and bruises of the cortex).

PATHOLOGY AND MORTALITY.—Excellent papers have been written on the pathological changes found in cases of head injury. From a study of the contributions of Apfelbach, Le Count and Apfelbach, Stewart, Bagley, Vance, Cassassa, Martland and Beling and conclusions derived from the present series, the following tabulation was compiled:

- I. Fracture of the skull, simple.
- II. Fracture of the skull, simple depressed.
- III. Fracture of the skull, compound.
- IV. Intracranial hæmorrhage.
 - A. Extradural, due to rupture of meningeal vessels, sinuses and diploe.
 - B. Intradural, due to pial tears, bruises or laceration of nervous tissue.
 - (1) Subarachnoid.
 - a. Generalized.
 - b. Localized.
 - (2) Intraparenchymatous.
 - a. Petichial.
 - b. Massive.
- V. Bruising or laceration of nervous tissue, with or without fracture of the skull.
- VI. Increased intracranial pressure.
 - A. Caused by any of the above.
 - B. With no demonstrable brain pathology.
- VII. Complications.
 - A. Meningitis.
 - B. Meningo-encephalitis.
 - C. Brain abscess.
 - D. Pneumocephalus.

It is not the purpose of the present few paragraphs to go into extensive detail as concerns the pathology in cases of head injury. The above tabulation is a helpful clinico-pathological compilation, which would remind one of all the various possibilities when treating a case of craniocerebral injury. It is to be emphasized, of course, that a good knowledge of the pathological

CRANIAL AND INTRACRANIAL INJURIES

changes is the only sound criterion in the treatment of such cases. A glance at the above tabulation shows that as physicians we are helpless in the presence of several conditions, at least for the present. It seems reasonable to operate on cases of compound fracture, depressed fracture with signs, and cases with extradural hæmorrhage. (Table XI.) In patients with subarachnoid hæmorrhage, particularly when it is generalized with clots over the entire one or both hemispheres, I wonder if any operative procedure is at all efficacious? The rationale of subtemporal decompression is not well understood. Through an opening in the temporal fossa only a very small fraction of the hæmorrhage is brought to light. Unless the operation is done for combating increased intracranial pressure, it has practically no place in the treatment of the case in so far as future results are concerned. The same reasoning may be carried on as concerns intraparenchymatous hæmorrhages

TABLE XI
Analysis of Operations—51 Cases

| SIMPLE DEPRESSIONS | | COMPOUND DEPRESSIONS | | MIDDLE MENINGEAL HEMORRHAGE | | SUBDURAL HEMORRHAGE WITHOUT DEPRESSION | | ENCEPHALOGRAM | | PLASTIC FOR PNEUMOCEPHALUS | |
|-----------------------|------|-------------------------|------|-----------------------------------|------|---|------|---------------|------|-------------------------------|------|
| 24 CASES | | 10 CASES | | 5 CASES | | 8 CASES | | 3 CASES | | 1 CASE | |
| REC. | DIED | REC. | DIED | REC. | DIED | REC. | DIED | REC. | DIED | REC. | DIED |
| 16 | 8 | 8 | 2 | 4 | 1 | 2 | 6 | 3 | 0 | 0 | 1 |

Analysis of operations in the series.

or bruises and lacerations of nervous tissue. Here again operative approach seems quite unreasonable particularly with petichial hæmorrhages and contusions of the cortex and in cases of laceration of the brain it may make matters worse. This is essentially true except if the operation is used to save the life of the patient. However, it is, of course, conceded that in some cases where the clinical findings point to a progressive lesion operative intervention is the only course we have. It seems that the more one thinks of the pathology in some cases of craniocerebral injury the more he believes in the conservative treatment of the same.

Although lumbar drainage is an important therapeutic agent in brain injury work at present, a glance at the above tabulation shows the limitations of the procedure, particularly as concern late results. If it is true that the presence of blood in the subarachnoid space is productive of inflammatory changes, this result must be brought about within the first few days, for we know that after bleeding is stopped the spinal fluid becomes clear again within about a week. It is reasonable to assume, therefore, that the presence of blood

in the subarachnoid space lays the foundation for the so-called late manifestations within the first few days. It is also known that even in clinics rabid on lumbar drainage in cases of brain injury only small amounts of spinal fluid are removed during the first few days, so that sufficient amount of blood remains in the subarachnoid space to do its devastating work. Matters are much worse in the presence of sufficiently large amounts of blood in the subarachnoid space causing the formation of clots over the cerebral sulci. Under such conditions lumbar puncture cannot remove the clots from over the hemisphere, and organization and absorption must go on irrespective of lumbar drainage. It seems to me that lumbar punctures are of greater immediate therapeutic value by virtue of control of intracranial pressure. It is unnecessary, I believe, to go on further and note that in so far as the future of the patient is concerned lumbar punctures cannot appreciably change the outcome in cases of laceration and bruises of the cortex, intraparenchymatous hæmorrhages, *etc.*, except if they are used to combat the intracranial pressure and thus minimize further damage by controlling the progressive swelling of nervous tissue.

In cases of skull fracture with brain injury one should not forget the possibility of co-existent pathology in other parts of the body. It must be emphasized that patients with injuries to the head receive the same in accidents which may injure any part of the body. In the present series among those with fatal termination there were twenty-seven cases with fractures elsewhere in the body, six cases with evident chest injury, ten cases with intra-abdominal injury, (ruptured spleen, two cases; ruptured liver, two cases; retroperitoneal hæmorrhages, six cases), three patients had associated spinal-column damage with transverse myelitis. It is conceded that most of these patients would have probably died with no associated head trauma. The combination of head injury and intra-abdominal injury is a serious one, in that the usual signs and symptoms referable to the abdomen are lacking due to the depressed state of the body. It is important in head injuries to have complete autopsies and in speaking of mortality in clinical groups it is important to know whether or not there were associated injuries elsewhere in the body. People (at times like myself) who review head injury series entering the institution before their time are confronted with a serious handicap particularly if their records are not complete. (Table VIII.)

In the present series there were eighty-nine cases of head injury who had associated injury to other parts of the body, or who may have died other than a skull death. They may be grouped in one paragraph as follows:

(1) Shot in the abdomen and head, recovered; (2) rupture of spleen, died; (3) fracture of lower jaw, recovered; (4) fractured leg, recovered; (5) fractured femur, tender and rigid abdomen, died; (6) fractured ribs, clavicle and subcutaneous emphysema, died; (7) fractured lower jaw, recovered; (8) fracture of both legs, and right wrist, laceration of elbow with ensuing cellulitis and septicæmia, died; (9) fractured femur, recovered; (10) fractured clavicle, recovered; (11) fractured lower jaw, died; (12) frac-

tured ribs and clavicle, recovered; (13) compound fracture of both legs with gas gangrene, died; (14) ruptured bladder, recovered; (15) ruptured kidney, recovered; (16) fracture of both clavicles, recovered; (17) crushing injury of one upper limb. the entire limb had to be amputated, died; (18) fractured ribs, recovered; (19) fractured femur, recovered; (20) fractured lower jaw, recovered; (21) fractured ribs, recovered; (22) fractured humerus, died; (23) puncture wound (ice pick) of pericardium with purulent pericarditis, recovered; (24) fractured pelvis and clavicle, recovered; (25) fractured leg, recovered; (26) fractured ribs, recovered; (27) fractured clavicle, recovered; (28) fractured clavicle, recovered; (29) peritonitis due to internal injuries, died; (30) fractured femur, recovered; (31) compound fracture of elbow and forearm, died; (32) fractured leg, recovered; (33) compound fractured tibia, died; (34) fracture-dislocation of cervical vertebræ with transverse myelitis, died; (35) fractured forearm, recovered; (36) fractured mandible and clavicle, recovered; (37) fractured clavicle, recovered; (38) fracture of both femurs, recovered; (39) fractured humerus, recovered; (40) fractured pelvis and bleeding from the vagina, died; (41) compound fracture of leg, died; (42) internal injuries, died; (43) fracture of both legs, fractured ribs, laceration of chest wall, with protruding lung, died; (44) fractured scapula and both hands, recovered; (45) fractured ribs, recovered; (46) fractured humerus, died; (47) fractured ribs, recovered; (48) fractured wrist, died; (49) fractured leg, died; (50) shot in both head and abdomen, died; (51) compound fracture of leg, died; (52) ruptured spleen, died; (53) ruptured liver, died; (54) compound fracture of leg, died; (55) fractured femur, and infected laceration of arm with cellulitis and septicæmia, died; (56) fractured ribs, subcutaneous emphysema, died; (57) fractured leg, died; (58) fractured ribs, followed by lobar pneumonia, died; (59) fractured ribs, improved; (60) fractured wrist, recovered; (61) fractured pelvis, recovered; (62) fractured femur, died; (63) fractured clavicle, recovered; (64) fractured ribs and internal injuries, died; (65) fractured femur, died; (66) fractured scapula and mandible, recovered; (67) fractured scapula, recovered; (68) fractured legs, recovered; (69) compound fracture of elbow, recovered; (70) fractured ribs, recovered; (71) fractured femur, recovered; (72) fractured clavicle, recovered; (73) fractured mandible, recovered; (74) fractured legs, died; (75) fractured pelvis, fracture-dislocation lumbar spine, died; (76) fractured leg, recovered; (77) fractured mandible, recovered; (78) fractured ribs, clavicle and humerus, recovered; (79) fractured clavicle, recovered; (80) fractured clavicle, recovered; (81) fractured femur, recovered; (82) fractured leg, recovered; (83) fractured leg, recovered; (84) fractured ribs, pneumothorax, lung collapse, lung abscess, compound fracture forearm, fractured leg, fractured pelvis, retroperitoneal hæmorrhages, died; (85) dislocation of femur, recovered; (86) fractured ribs, recovered; (87) fractured jaw, recovered; (88) apoplexy, died; (89) fracture-dislocation cervical vertebræ with transverse myelitis, died.

In the present series of 718 cases there were 138 deaths. The mortality

in the entire group irrespective of associated injuries contributory to death is around 19 per cent. Among those where a fracture of the skull was demonstrated there were 132 deaths giving a mortality of around $25\frac{1}{2}$ per cent.* Fifty-one cases were operated on with eighteen deaths. The operative mortality is therefore around 37.5 per cent., leaving out of the total group the cases where encephalography was resorted to.

The complications of head injury as stated above are meningo-encephalitis, brain abscess and pneumocephalus. (Fig. 4.) In this series there were five cases of meningitis with four deaths. The one recovery followed repeated lumbar punctures. The organism isolated was a strep with the characteristics of Koch-Weeks bacillus. For purposes of drainage lumbar puncture is satisfactory except where there is block. Only under such circumstances is one justified to resort to operative ventricular or cisternal drainage. Pregl's septoid by the carotid route was not used in this series. Crawford states that the results obtained in different clinics justify its use in such cases. It is probably true that infection of the middle ear and the mastoid is the most frequent cause of meningitis in cases of head injury. In the Vance series the paranasal sinus infections were next in order. In the present study there were three cases of otitis media of which two developed mastoid infection. Meningitis followed bleeding ears in two cases, and paranasal involvement in three cases.

There were two cases of aërocele of the frontal sinus and one case of genuine pneumocephalus. The latter was caused by a compound fracture in the posterior third of the skull near the external occipital protuberance. There was cerebrospinal fluid leakage at the site of damage. X-rays showed air in the ventricles. She was operated on, the area of depression exposed, the wound débrided and a three-layer repair obtained. Unfortunately, the wound opened within forty-eight hours. A second attempt at the repair was fruitless. The patient died of meningo-encephalitis. Pneumocephalus complicating skull fracture is at present a fairly common observation, undoubtedly due to the routine use of rays in cases of head injury. Several papers have

* In 475 cases the position was verified by inspection, ray or autopsy. An additional twenty-eight deaths occurred in the series who were neither rayed nor autopsied but they did show various clinical evidences associated with skull fracture. In twelve cases with bleeding from the ear the rays were negative and the patients recovered so that the presence of fracture could not be ascertained. Bleeding from the ear is usually considered a positive evidence of skull fracture and this is undoubtedly true in the greatest majority of cases. However, in the present series one case of unilateral bleeding who also had bloody spinal fluid did not show a fracture at autopsy. Therefore, ruptured drum membrane does not always signify a fracture of the skull in these cases. To the total of 515 may also be added four cases with bloody spinal fluid who were transferred to other institutions before rays could be procured. It is, therefore, evident that 519 cases can be justly grouped under the classification of skull fracture.

Among those who died there were five cases with bloody spinal fluid who showed no fracture of the skull. One case of fracture dislocation of cervical vertebræ showed clinical evidences of brain dysfunction with no associated fracture of the cranium. This leaves 132 cases. Of this group, only among 104 the position of the fracture was verified.

CRANIAL AND INTRACRANIAL INJURIES

been written on the subject, among those being the contributions of Dandy, Bromberg, Winterstein, Miller, Klemme, and Snoke, and others. Many cases have been treated conservatively with good results. However, in selected cases operative repair is undoubtedly the logical procedure.

TREATMENT.—When one follows the fatal cases to the autopsy room one is impressed by the fact that in a great many no present-day method of approach, whether it be conservative or operative, is of any avail. This is true in some cases with generalized bruising of the brain, general subarachnoid hæmorrhage, contrecoup laceration of the frontal lobes, large intraparenchym-



FIG. 4. An example of pneumocephalus.

atous hæmorrhages, extreme degrees of intracranial pressure, *etc.* It is true that with present-day therapy a certain number of head injuries will die on entrance or soon after entrance into the hospital. There is little to be hoped for in this group, although close scrutiny and careful selection may save a very few among them.

Treatment of skull fracture and head injuries has been ably discussed by several investigators (Kocher, Quincke, Jackson, Stewart, Sachs, Bower, Munro, Peet, McClure and Crawford, Fay, Mock, Ireland, and many others). In the next few paragraphs I propose to discuss as briefly as possible the treatment instituted in cases of head injury in the Receiving hospital. Through-

out this paper in the discussion of specific complications suggestions have been given as concerns treatment.

On the basis of treatment received the present series of 718 cases may be roughly grouped into three classes: First, those patients who were confined to bed with the head of the bed elevated, ice bag applied to the head, fluid intake restricted and where concentrated solutions of magnesium sulphate were given by rectum for three days or longer. This comprised a little over half of the cases and they were kept in the hospital not less than twelve days. Second, those who had added treatment to relieve increased intracranial pressure by the administration of intravenous glucose (50 per cent.) and spinal drainage. This comprised a little less than 40 per cent. of the cases. Third, those where in addition to conservative relief of intracranial pressure operative intervention was also effected. This constituted about 7 per cent. of the series. On the whole the mode of treatment in this hospital for the past five years has been essentially the same as prescribed by Mock in his excellent paper on the treatment of skull fracture. Special emphasis is laid, as pointed out by several authors, on the treatment of traumatic shock in cases of head injury at entrance into the hospital.

Much has been written about the administration of various drugs in the treatment of increased intracranial pressure. I find 50 per cent. glucose (Weed and McKibben, Peet and others) in 100 cubic centimetre doses administered every eight hours superior to various other concentrated salts such as sodium chloride solutions intravenously, magnesium sulphate solutions by mouth or rectum. Glucose solutions are doubly helpful in that they furnish the patient with a certain number of calories helpful in maintaining metabolism. Particularly during the state of shock concentrated solutions of glucose and intravenous saline have been helpful in maintaining the fluid balance and at the same time checking the increasing intracranial pressure. As stated above, the patients are carefully watched for the amount of fluid intake and to insure that they receive about 1,000 cubic centimetres daily, supplemental subcutaneous infusions are also administered. Excessive dehydration is serious and the patients should have sufficient fluid to sustain fairly normal metabolism. I am not familiar with the use of caffeine sodium benzoate as an agent to combat increased intracranial pressure, which Kennedy and Wortis suggest. It is used quite frequently in patients soon after entrance into the hospital to help circulation and the heart.

A few words about lumbar puncture in cases of head injury. This is an important diagnostic and therapeutic procedure. Lumbar drainage should never be done before a careful study of the patient, for the indiscriminate use of this may cause mistakes in diagnosis and possibly undesirable results in some cases, such as in patients with extradural clot, and those with active bleeding from the brain. If it is true that the presence of blood in the subarachnoid space is productive of inflammatory reaction lumbar puncture becomes doubly important in minimizing such an outcome for the patient in the future, although it is questionable that lumbar drainage as it is usually

performed (fractional drainage) does actually remove all of the irritating factor (blood). Much depends on the amount of blood in the subarachnoid space. If there is sufficient bleeding to cause the formation of clots over the cerebral sulci, spinal puncture in such cases cannot afford a complete removal of blood and its products from the subarachnoid space. The blood removed by drainage is what there exists in the cerebrospinal fluid, in suspension. Repeated lumbar punctures do not cause clotted blood to go into suspension in the spinal fluid. At least this is the only conclusion one can arrive at after exploring cases with subdural hæmorrhage. In such cases even though repeated lumbar punctures were performed before operation clots were found over the cerebral cortex. It is therefore to be assumed that lumbar drainage is limited in cases of extensive subarachnoid hæmorrhage in so far as complete removal of blood (irritating factor) from over the hemispheres is concerned. Undoubtedly, in such cases, organization takes place just the same, irrespective of lumbar puncture.

Particularly if performed on a patient soon after entrance into the hospital, lumbar puncture should be done carefully and always with a manometer, as Fay stresses. Soon after injury its administration may be serious in that it may cause further hæmorrhage and further increase in intracranial pressure. *In this series I have seen three deaths following soon after lumbar puncture.* Unless it is done for diagnostic purposes spinal punctures are not performed in this clinic only after six to eight hours following the accident. The reasons for this are evident. Particularly in serious cases shock must be disposed of first. In a case of active bleeding from the brain lumbar puncture may cause further hæmorrhage by decompressing the organ. Among those whose death occurs within six hours after entrance I doubt if lumbar puncture can alter the situation. In some cases where it is necessary for differential diagnostic purposes, punctures may be performed, but in the majority this will not be needed, for the clinical manifestations are evident.

In some cases with fractured pelvis, fractured lower extremity bones, *etc.*, I have resorted to cysterna punctures. Here again I use the manometer and allow the escape of sufficient fluid to bring the pressure down twenty-five to seventy-five millimetres of water. In this series cysterna punctures were done in eleven cases. It is really simpler than spinal puncture and may be performed with more ease.

Immediate therapeutic results with lumbar puncture in some cases of head injury are remarkable. The period of unconsciousness is lessened in many cases. In some patients with convulsions lumbar drainage has supplanted operative approach in this series. Two cases of aphasia were treated by drainage with marked improvement in the ability to speak soon after the procedure. One case of meningitis was cured with repeated lumbar punctures. There is no question about the usefulness of this procedure in selected cases, particularly for immediate therapeutic results. However, I question its efficacy as a factor in minimizing the undesirable post-traumatic sequelæ in all cases of head injury. Certainly it is not the blood alone in the

subarachnoid space that causes adhesive changes involving the lepto meninges. Many cases of head injury have lacerations of the central nervous system, small intraparenchymatous hæmorrhages, bruises and contusions of the brain which cannot be remedied by any amount of lumbar drainage except if the latter were used for its immediate therapeutic results. (Also see p. 354.)

Operations.—There were fifty-one cases operated on in this series. Of these the majority belongs to the group of simple depressions. Of the twenty-four simple depressions a great many had serious brain damage. Two had rupture of the longitudinal sinus, one had brain abscess, two had severe contusion of the cortex with subarachnoid hæmorrhage, two died of associated septicæmia. Most of the remaining seventeen were asymptomatic or slightly symptomatic simple depressions. There were ten cases operated on for compound depressions, with eight recoveries. All but two were closed tightly at the conclusion of the operation. Two cases with frontal compound fractures were packed according to the method of Peet to hold the dura against the brain in the area of laceration. There were five cases of middle meningeal hæmorrhage, with four recoveries and one death. Eight patients were operated on who showed focal symptoms and at operation generalized subarachnoid hæmorrhage was discovered. Of these six died and two had very stormy convalescence. They were both in the hospital for over two months, one was discharged to an asylum and the other left for home, both in very definitely deranged mental state. Cases of subarachnoid hæmorrhage with localizing signs in this series have been very discouraging as concerns post-operative result. Three patients were subjected to encephalography.

When to operate in cases of skull fracture is a question answered in many contributions. At present the answer is more or less standard as concerns certain lesions. For methodical purposes I should like to discuss under separate heading the various types of lesions where operation is considered the best approach to the problem.

Compound Fractures.—These are truly emergency cases in skull fracture work. Particularly those with depressions are operated on as soon as the patient's condition permits. It is very important to allow them to recover sufficiently from shock and other depressing factors. After all, operating on the patient and having the latter die on the table or soon after is defeating one's purpose even though it may be considered the correct dogmatic procedure. In two patients I waited eighteen and twenty-six hours respectively before operation, and after thorough débridement both were closed tightly. (Figs. 5 and 6.) They both recovered. Particularly when working in the frontal region it may be worth while to keep in mind the removal of the depressed area *en bloc* so that post-operative deformities may be at a minimum. Following careful cleansing and adjustment, the piece may be replaced. The type of incision depends entirely on the type of laceration and its extent. In some cases the tripod incision that Cushing describes in his consideration of war wounds is excellent. In others where the skin laceration is more or less a puncture wound the flap incision may be more profitable. The ideal in

Figs. 5 and 6.—Gun-shot wound of the skull. These radiographs show the extent of laceration all pieces of bone and replacing them before closure. Patient was operated on eighteen hours after entrance. The wound was closed without drainage.

Fig. 5.

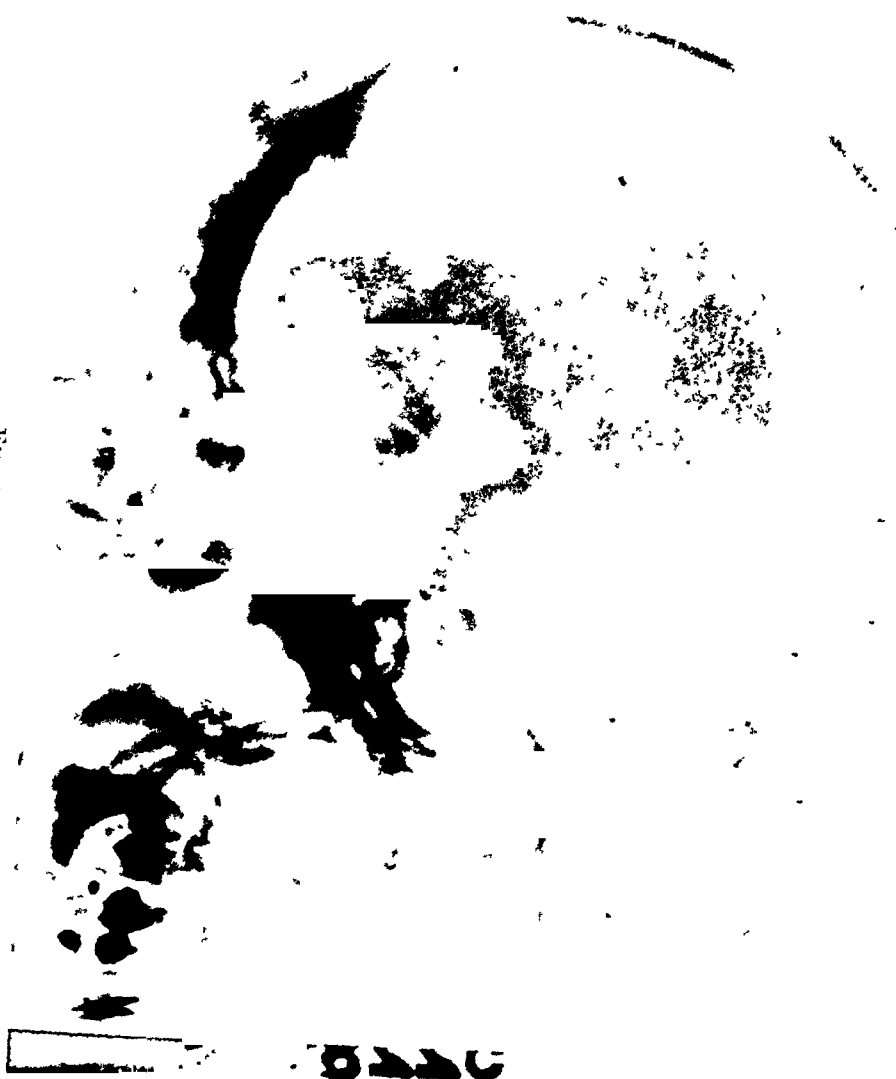


Fig. 6.



At present the contour of the forehead is good.

treating compound fractures is first to prevent infection, and second, and not at all unimportant, to give the patient as little deformity as is compatible with careful work. I try to close all cases without drainage if possible.

Simple Depression.—A majority of simple depressions are practically asymptomatic. If asymptomatic they are not considered emergency cases and need not be operated on immediately. Particularly slight depressions with no symptoms are left to the patient's wish in so far as an operation is concerned. It is surprising to note that a great many depressed fractures remain free of symptoms for long periods of time, so much so that one doubts the necessity for elevation of asymptomatic depressions. It seems that there is a great deal to the experimental findings of Naffziger and Glaser, where they state that injury to the brain with depressed fractures occurs at the time of the accident, that the presence of a depression as such with no initial brain injury is not productive of brain dysfunction. Possibly this may not be true in cases where pieces of bone actually pierce the dura and the brain and their presence in such a position may be productive of more connective tissue than would be the case if these were removed. At any rate, it is important to study the X-rays in these cases carefully, and after thorough study of the patient clinically one can arrive at a sane conclusion as to the proper procedure. Where an operation is undertaken for a simple depression, particularly in the region of the forehead, it is important to keep in mind the values of bloc trepanation. This method is of greater value in simple depressions as compared with those where there is an overlying laceration of the skin. Following the removal of the entire area of depression *en bloc* and readjustment of the depressed pieces, the piece of bone may be replaced with better eventual æsthetic results. I prefer the flap incision in these cases.

Particularly with depressions in the forehead region, block anæsthesia may be used. A few cubic centimetres of 2 per cent. novocaine solution injected in the supra-orbital notch or foramen on both sides with additional infiltration in the area between these two landmarks will anæsthetize the area of distribution of the supra-orbital and the supratrochlear nerves. If the lesion extends far enough laterally the auriculotemporal branch of the trigeminal nerve may also be blocked.

Extradural Hæmorrhage.—A majority of these are cases with middle meningeal hæmorrhage. I have seen two cases of lateral sinus rupture with an extradural hæmorrhage in the posterior third of the skull. The diagnosis of the latter condition seems difficult on clinical grounds. Possibly one may suspect such a lesion by a study of X-rays, presence of depressions in the occipital bone, *etc.* Cases of middle meningeal hæmorrhage are considered fit for emergency treatment in this Institution. In the typical case they are operated on many hours after the accident because of a lucid period which is usually twelve hours or more. In the presence of associated brain damage the lucid period may be totally absent. In cases of middle meningeal hæmorrhage I prefer an osteoplastic flap. However, before this is done a diagnostic trephine hole is made in one or two places in the line of the osteoplastic incision to verify the presence of an extradural clot. After verification I pro-

ceed with the flap operation. In the presence of a lucid period it is probably not necessary to open the dura, but if the patient has been in a serious condition throughout and the dura bulges following the removal of the extradural clot it is advisable to incise the dura, for in a certain number of cases, with meningeal rupture there may be associated intracerebral hematoma in the same sided temporal pole of the hemisphere. The convalescence in cases of extradural hæmorrhage is much shorter with a flap operation and in this clinic we prefer it to the operation of subtemporal decompression. Where it is impossible to do the flap operation due to the presence of lacerations subtemporal decompression may be performed. I usually leave a drain in the epidural space which is removed the following day.

Subdural Hæmorrhage.—Cases of subdural hæmorrhage with progressive localizing signs such as contralateral paresis of the body, unilateral reflex changes or Jacksonian epilepsy are operated on in this clinic, but the results are far from satisfactory. The usual operation is subtemporal decompression. Quite frequently the opening into the skull is not sufficiently large to afford complete removal, but unfortunately, as shown in many autopsy cases, one would have to actually expose the entire one-half or the whole of the brain in order to remove all of the clots, because it is notoriously true that the majority of cases of subdural hæmorrhage are not localized. The outcome in cases who recover is poor, at least so far as my own experience is concerned, the convalescence is long and drawn-out, and quite frequently the patients succumb to intercurrent disease, such as pneumonia.

In conclusion, it can be stated that operations of an emergency nature in cases of skull fracture are those with compound fracture and those with extradural hæmorrhage. The results in these cases are very gratifying. Patients showing progressive focal signs indicative of a localized brain lesion are also considered operable. Careful study of the patient and accurate pre-operative diagnosis are important in the latter group. It is unfortunate that patients are of no help and cannot coöperate in order to complete the clinical studies in a great many cases. Future work possibly may clarify some of these present-day impossible cases. Conservative watchfulness is probably the best slogan to follow in skull fracture work, but one should emphasize the "watchfulness" part of the slogan.

No paper on the treatment of cases of acute brain injury is complete without consideration of methods to check undesirable sequelæ. In case of operative approach the question of visible deformities should be remembered. It is proper to minimize them in so far as this is compatible with careful work. The after-care of cases of brain injury is important. Good habits, moderate mental exertion, restricted fluid intake (Fay) and the occasional use of dehydrating agents are valuable. The régime of restricted fluids is certainly helpful in many cases and future results will undoubtedly tell us more of its merits or short-comings.

In this clinic we do not suggest various symptoms by ardent questioning. If they have headache, tinnitus or dizzy spells they invariably tell the examiner about it. A certain number only need the proper suggestion to return at the

next visit complaining of the symptom suggested to them. In this day of various methods of compensation, whether it be from an insurance company, lodge or other societies, subjective post-traumatic sequelæ are common, some undoubtedly genuine and others either manufactured or made worse by various prospects. Psychotherapeutic measures are invaluable. A proper evaluation of the individual's mental state with corresponding psychic therapy and suggestion is helpful. I wonder if the scarcity of subjective post-traumatic sequelæ in children may not be partially explained on the basis that among them the problems of the psyche, proper adjustment and rehabilitation are simpler.

CONCLUSIONS AND SUMMARY.—(1) Seven hundred and eighteen cases of cranial and intracranial injury are reported. In 475 cases the position of the fracture was ascertained by ray, inspection or autopsy. In this group there were twenty-nine frontal sinus fractures, twenty-six foramen magnum fractures, sixty-nine depressions. The most numerous were fractures in the middle third of the skull.

(2) There were 129 cases of bleeding from the ear. The mortality was 31.3 per cent. with right-sided, 30.6 per cent. with left-sided, and 68.9 per cent. with bilateral bleeding. There were two cases of meningitis, three of otitis media, and two of mastoiditis in this group. There were fourteen cases of facial paralysis. Among those with unilateral bleeding eighty-four were rayed with positive fracture finding in 87 per cent. Even though there may be bleeding from a given ear the fracture of the skull may be elsewhere than in the vicinity of that ear.

Bleeding from the nose occurred in 24 per cent. of the cases, vomiting in 21 per cent. and incontinence in 7 per cent.

(3) Convulsions were seen in forty-six cases (6 per cent.). There were twenty-three with Jacksonian attacks, eighteen with epileptiform attacks and five with attacks characteristic of decerebrate rigidity.

(4) Five cases of catatonic states are discussed. The diagnosis of laceration of orbital surface of frontal lobes is considered. Examples of the syndrome of the superior longitudinal sinus and alternating oculomotor paralysis in cases of middle meningeal hæmorrhage are given.

(5) Associated injury in other parts of the body is considered and examples given. There were five cases of meningitis with one recovery. Two cases of aërocele of the frontal sinus, one case of pneumocephalus are discussed.

(6) The values and short-comings of lumbar puncture are considered. It is stated that lumbar puncture should never be done without a careful neurological examination of the patient. Indications for lumbar drainage (always with a manometer) are (a) diagnostic purposes in a few cases; (b) continued unconsciousness with no focal neurological signs; (c) severe post-traumatic headaches and continued drowsiness; (d) cases of convulsions with no associated focal signs to justify operative approach; (e) cases of meningitis.

Not all cases of head injury deserve lumbar drainage. We should be

guided by the clinical findings. As a rule lumbar punctures are not done in this clinic before six or eight hours have elapsed.

In cases of fractured pelvis, lower extremity bones, where lumbar puncture would be difficult to perform, cisterna puncture may be used with advantage.

(7) Fifty-one operations are discussed. Indications for operation are: (a) compound fracture; (b) extradural hæmorrhage; (c) intradural hæmorrhage with focal signs and not responding to lumbar drainage; (d) depressed fractures (slight depressions and depressions in the frontal sinus region are treated conservatively in the absence of findings to justify operation); (e) progressive focal signs not responding to lumbar drainage.

(8) Mortality in the entire series irrespective of injuries elsewhere in the body is around 19 per cent. Among those where a fracture of the skull was demonstrated, it is around 25 per cent.

BIBLIOGRAPHY

- ¹ Andruss: Quoted by Naffziger.
- ² Apfelbach, C. W.: Fractures of Cranial Bones. *Arch. Surg.*, vol. iv, p. 434, 1922.
- ³ Bagley, Jr., C.: Blood in Cerebrospinal Fluid. *Arch. Surg.*, vol. xvii, p. 18, 1928.
- ⁴ Bagley, Jr., C.: The Grouping and Treatment of Acute Cerebral Traumas. *Arch. Surg.*, vol. xviii, p. 1078, 1929.
- ⁵ Beekman, F.: Head Injuries in Children. *ANNALS OF SURGERY*, vol. lxxxii, p. 355, 1928.
- ⁶ Besley, F. A.: A Contribution to the Subject of Skull Fracture. *Jour. Am. Med. Assn.*, vol. lxi, p. 345, 1916.
- ⁷ Blakeslee, G. A.: Eye Manifestations in Fractures of the Skull. *Arch. Ophthal.*, vol. ii, p. 566, 1929.
- ⁸ Bower, F. O.: Management of Injuries to the Cranium and Its Contents. *ANNALS OF SURGERY*, vol. lxxviii, p. 433, 1923.
- ⁹ Bromberg, W.: Cerebrospinal Rhinorrhœa with Pneumocephalus Secondary to Skull Fracture. *Jour. Am. Med. Assn.*, vol. xc, p. 2019, 1928.
- ¹⁰ Brünner, H.: Pathologie und Klinik der Erkrankungen des Inner-Ohres nach stumpfschädel traumen. *Monatschr. f. Ohren.*, vol. lix, pp. 697, 763 and 922, 1925.
- ¹¹ Campbell, E. H.: Cerebrospinal Rhinorrhœa Following Intranasal Surgery. *Am. Jour. Otorhinolaryng.*, vol. xxxvii, p. 865, 1928.
- ¹² Cassassa, C. B.: Multiple Traumatic Cerebral Hæmorrhages. *Proc. N. Y. Path. Soc.*, vol. xxiv, p. 101, 1924.
- ¹³ Crawford, A. S.: The Intracarotid Treatment of Meningitis, Experiences with Pregl's Solution of Iodine. *Jour. Am. Med. Assn.*, vol. xcvi, p. 1531, 1932.
- ¹⁴ Cushing, H.: Notes on Penetrating Wounds of the Brain. *British Med. Jour.*, vol. i, p. 221, 1918.
- ¹⁵ Dandy, W. E.: Pneumocephalus. *Arch. Surg.*, vol. xii, p. 948, 1926.
- ¹⁶ Davis, E. D. D.: Injuries of the Ear Arising from Fractures of the Skull. *British Med. Jour.*, vol. ii, p. 741, 1928.
- ¹⁷ Davis, L.: Surgical Indications in the Treatment of Skull Fracture. *Internat. Jour. Med. Surg.*, vol. xliii, p. 621, 1930.
- ¹⁸ Dejerine: *Sémiologie du système nerveux*. Paris, 1914.
- ¹⁹ Fay, T.: The Control of Intracranial Pressure. *Jour. Am. Med. Assn.*, vol. lxxxiv, p. 1261, 1925.
- ²⁰ Fay, T.: Generalized Pressure Atrophy of Brain Secondary to Traumatic and Pathologic Involvement of the Pacchionian Bodies. *Jour. Am. Med. Assn.*, vol. xciv, p. 245, 1930.

- ²¹ Fay, T., and Winkelman, N. W.: Widespread Pressure Atrophy of the Brain and Its Probable Relation to the Function of the Pacchionian Bodies and the Cerebrospinal Circulation. *Am. Jour. Psychiat.*, vol. ix, p. 667, 1930.
- ²² Glaser, M. A., and Shafer, F. P.: Skull and Brain Traumas. Their Sequelae. *Jour. Am. Med. Assn.*, vol. xcvi, p. 239, 1932.
- ²³ Gowers, W. R.: *Diseases of the Nervous System*. Philadelphia, 1893.
- ²⁴ Green, T. M.: Management and Treatment of Brain Injuries. *Internat. Clin.*, vol. ii, p. 239, 1924.
- ²⁵ Gurdjian, E. S.: Catatonic Motor Phenomena in Skull Fracture with Brain Injury. *Jour. Nerv. Ment. Dis.*, vol. lxxiii, p. 493, 1931.
- ²⁶ Gurdjian, E. S.: Ear Complications in Acute Craniocerebral Injury. *Radiology*, vol. xviii, p. 74, 1932.
- ²⁷ Gurdjian, E. S.: Alternating Oculomotor Paralysis in Middle Meningeal Hæmorrhage. *Arch. Neur. Psychiat.*, vol. xxviii, p. 26, 1932.
- ²⁸ Gurdjian, E. S., and Schlafer, N. H.: The Diagnosis of Laceration of the Orbital Surface of Frontal Lobes. *Arch. Neur. Psychiat.*, vol. xxvi, p. 583, 1931.
- ²⁹ Gurdjian, E. S., and Shawan, H. K.: Management of Skull Fracture Involving the Frontal Sinus. *ANNALS OF SURGERY*, vol. xcv, p. 27, 1932.
- ³⁰ Hoff, H., and Schilder, P.: Einige Bemerkungen über Haltungs- und Stelle-reflexe bei katatonen Bewegungsstörungen. *Wien. med. Wochschr.*, vol. lxxvii, p. 1253, 1927.
- ³¹ Holbrook, F. R.: Diagnosis and Management of Head Injuries. *Jour. Am. Med. Assn.*, vol. lxxxiii, p. 489, 1924.
- ³² Holman, E., and Scott, W. I.: Significance of Unilateral Dilatation Fixation of Pupils in Severe Skull Injuries. *Jour. Am. Med. Assn.*, vol. lxxxiv, p. 1329, 1925.
- ³³ Holmes, G., and Sargent, P.: Injuries to the Superior Longitudinal Sinus. *British Med. Jour.*, vol. ii, p. 493, 1915.
- ³⁴ Ireland, J.: Fracture of the Skull in Children. *Arch. Surg.*, vol. xxiv, p. 23, 1932.
- ³⁵ Jackson, H.: The Management of Acute Cranial Injuries by the Early Exact Determination of the Intracranial Pressure and Its Relief by Lumbar Puncture. *Surg., Gynec., and Obst.*, vol. xxxiv, p. 494, 1922.
- ³⁶ Jackson, A. A.: Present-day Management of Brain Injuries. *Internat. Jour. Med. Surg.*, vol. xliii, p. 629, 1930.
- ³⁷ Kennedy, F., and Wortis, S. B.: Modern Treatment of Increased Intracranial Pressure. *Jour. Am. Med. Assn.*, vol. xcvi, p. 1284, 1931.
- ³⁸ Kennedy, F., and Wortis, S. B.: How to Treat Head Injuries and Appraise Them. *Jour. Am. Med. Assn.*, vol. xcvi, p. 1352, 1932.
- ³⁹ Kleist, K.: Paralysis Agitans, Stammganglien und Mittelhirn. *Deut. med. Wochschr.*, vol. li, p. 1725, 1925.
- ⁴⁰ Kocher, T.: Hirnerschütterung, Hirndruck und chirurgische Eingriffe bei Hirnerkrankungen. *Nothnagel's system*, 1901.
- ⁴¹ LeCount, E. R., and Apfelbach, C. W.: Pathologic Anatomy of Traumatic Fractures of Cranial Bones. *Jour. Am. Med. Assn.*, vol. lxxiv, p. 501, 1920.
- ⁴² Lévi-Valensi, and Ezes: Paraplegie Corticale Traumatique. *L'Encephale*, vol. xxv, p. 667, 1930.
- ⁴³ Lewy: Die Lehre von Tonus und der Bewegung zugleich systematische Untersuchung zur Klinik, Physiologie und Pathogenese der Paralysis Agitans. *Springer, Berlin*, 1923.
- ⁴⁴ Linthicum, F. H., and Rand, C. W.: Neuro-otological Observations in Concussion of the Brain. *Arch. Oto-laryng.*, vol. xiii, p. 785, 1931.
- ⁴⁵ Martland, H. S., and Beling, C. C.: Traumatic Cerebral Hæmorrhage. *Arch. Neur. Psychiat.*, vol. xxii, p. 1009, 1929.
- ⁴⁶ McClure, R. D., and Crawford, A. S.: Management of Craniocerebral Injuries. *Arch. Surg.*, vol. xvi, p. 451, 1928.
- ⁴⁷ McCreery, J. A., and Berry, F. B.: Study of 520 Cases of Cranial Fracture. *ANNALS OF SURGERY*, vol. lxxxviii, p. 890, 1928.

CRANIAL AND INTRACRANIAL INJURIES

- ¹ Miller, G. G.: Cerebral Concussion. *Arch. Surg.*, vol. xiv, p. 891, 1927.
- ² Miller, R. K., and Lauppe, F. A.: Mastoiditis Following Skull Fracture. *Jour. Mich. State Med. Soc.*, vol. xxix, p. 912, 1930.
- ³ Miller, S. W., Klemmer, R. N., and Snoke, P. O.: Traumatic Pneumocephalus. *Jour. Am. Med. Assn.*, vol. xcvi, p. 172, 1931.
- ⁴ Mock, H. E.: Management of Skull Fractures and Intracranial Injuries. *Jour. Am. Med. Assn.*, vol. xcvi, p. 1430, 1931.
- ⁵ Mock, H. E.: Skull Fracture and Cerebral Injuries. *Internat. Jour. Med. Surg.*, vol. xlv, p. 1, 1931.
- ⁶ Munro, D.: The Therapeutic Value of Lumbar Puncture in the Treatment of Cranial and Intracranial Injuries. *Boston Med. Surg. Jour.*, vol. cxciii, p. 1187, 1925.
- ⁷ Naffziger, H. C.: Skull Fracture. *Nelson's Loose-Leaf Living Surgery*, vol. iii, p. 833. Nelson and Sons, New York, 1927.
- ⁸ Naffziger, H. C., and Glaser, M. A.: An Experimental Study of the Effects of Depressed Fracture of the Skull. *Surg., Gynec., and Obst.*, vol. li, p. 17, 1930.
- ⁹ Peet, M. M.: Reduction of Increased Intracranial Pressure by Intravenous Administration of Glucose and Hypertonic Ringer's Solution. *Jour. Am. Med. Assn.*, vol. lxxxiv, p. 1994, 1925.
- ¹⁰ Peet, M. M.: Symptoms, Diagnosis and Treatment of Acute Cranial and Intracranial Injuries. *Indust. Doctor*, vol. v, No. 7, 1927.
- ¹¹ Quincke, H.: Die diagnostische und therapeutische Bedeutung der Lumbalpunktion. *Deut. med. Wochschr.*, vol. xxxi, p. 1825, 1905.
- ¹² Rand, C. W.: The Significance of a Dilated Pupil of a Homolateral Hemiplegic Side in Cases of Intracranial Hemorrhage Following Head Injuries. *Arch. Surg.*, vol. xviii, p. 1176, 1929.
- ¹³ Sachs, E.: Fractures of the Skull. *Surg. Clin. N. Amer.*, vol. ii, p. 1571, 1922.
- ¹⁴ Schück, F.: Hirnverletzung und Bewusstseinslage. *Arch. f. klin. Chir.*, vol. clxvii, p. 322, 1931.
- ¹⁵ Shemeley, W. S.: Basilar Fracture of the Skull with Temporal Bone Involvement. *Laryngoscope*, vol. xxxviii, p. 312, 1928.
- ¹⁶ Sicard: Le syndrome du carrefour condylo-déchiré postérieur. *Marseille med.*, vol. liii, p. 383, 1917.
- ¹⁷ Stewart, J. W.: Fracture of the Skull. *Jour. Am. Med. Assn.*, vol. lxxvii, p. 2030, 1921.
- ¹⁸ Stookey, B.: Multiple Cranial Nerve Paralysis. *Jour. Nerv. Ment. Dis.*, vol. lvii, p. 529, 1923.
- ¹⁹ Swift, G. W.: Head Injuries of Moderate Degree. *Surg., Gynec., and Obst.*, vol. lxi, p. 576, 1931.
- ²⁰ Teachenor, R. F.: Intracranial Complications of Fracture of the Skull Involving Frontal Sinus. *Jour. Am. Med. Assn.*, vol. lxxxviii, p. 987, 1927.
- ²¹ Urechia, C. I.: Note sur l'état du noyau dentelé dans un cas de catatonie. *Rev. Neur.*, vol. ii, p. 171, 1922.
- ²² Vance, B. M.: Fractures of the Skull. *Arch. Surg.*, vol. xiv, p. 1023, 1927.
- ²³ Vernet: Sur le syndrome du trou déchiré postérieur. *Paris Med.*, vol. vii, p. 78, 1917.
- ²⁴ Villaret, M., and Faure-Beaulieu, M.: Le syndrome nerveux de l'espace retroparotien. *Presse Med.*, vol. xxvi, p. 591, 1918.
- ²⁵ Vogt, Cecile, and Oskar: Diseases of the Striate System. *Jour. f. Psychol. und Neur.*, vol. xxv, p. 3, 1920.
- ²⁶ Weed, L. H., and McKibben, P. S.: Pressure Changes in Cerebrospinal Fluid Following Intravenous Injection of Solutions of Various Concentration. *Am. Jour. Physiol.*, vol. xlvi, p. 512, 1919.
- ²⁷ Willensky, A.: Fracture of the Skull with Special Reference to Its Neurological Manifestations. *ANNALS OF SURGERY*, vol. lxx, p. 404, 1919.
- ²⁸ Wilson, S. A. K.: Modern Problems in Neurology. Wm. Wood and Co., 1929.
- ²⁹ Winstenstein, O.: Über 3 Fälle von Pneumocephalus traumaticus. *Arch. f. klin. Chir.*, vol. clx, p. 610, 1930.

CHEMICAL TREATMENT OF THE PERIOSTEUM IN THORACOPLASTY TO INHIBIT RIB REGENERATION

BY C. M. VAN ALLEN, M.D.

OF PEIPING, CHINA

FROM THE DEPARTMENT OF SURGERY, PEIPING UNION MEDICAL COLLEGE

FIVE years ago, Jerome Head¹ described experiments in which he tested the effectiveness of various chemical agents for preventing osteogenesis after subperiosteal costectomy. He removed pieces of several ribs from each of a number of dogs and then painted the rib-free periosteum with the chemicals before closing the wound. After a lapse of time amply sufficient for bone to regenerate, the animals were sacrificed and the rib beds were examined by X-rays and dissection. Zenker's solution seemed the most suitable of the agents employed, since it prevented osteogenesis completely without producing appreciable necrosis. Meiss² reported a similar investigation in 1930. Although he found Zenker's solution quite effective in preventing the formation of new bone, he noted perforation into the pleural cavity in one instance and symptoms (undescribed) of systemic poisoning. He preferred 10 per cent. solution of formalin—an agent not tested by Head—for it had all the advantages of Zenker's solution and none of the disadvantages.

Both authors suggested clinical uses for their methods in certain types of thoracoplasty. Thus, it was recalled that where ribs have to be resected in stages for producing collapse of the chest-wall, "the true collapse occurs only with the removal of the last ribs. Until then the part of the wall of the chest which is already mobilized hangs from the ribs like the curtain of a tent, and, if the bones reform in this position, the final collapse is compromised."¹ Furthermore, the lapse of three weeks between the first and last stages of operation may be sufficient to bring about this undesired result, and yet that or even a much greater interval between the stages is often advantageous or imperative, in order to replenish the patient's strength and morale, to prevent advancement of associated diseases, to permit infected wounds to heal, to test the effectiveness of preceding stages, *etc.* It seemed to Meiss that the method would be useful in paravertebral extrapleural thoracoplasty for pulmonary tuberculosis because it would allow wider intervals between the stages of operation and would permit the chest-wall to continue collapsing slightly for several months after operation, in response to the gradual fibrosis and shrinkage of the lung that occurs with the healing of the disease. He believed that the prevention of rib regeneration would not leave the thoracic wall sufficiently unstable to jeopardize the healing of the pulmonary lesion, for he knew of a patient who had received paravertebral thoracoplasty by *supraperiosteal* costectomy and had obtained full benefit to the tuberculous lesion of the lung. Head advised against this application

of the method, on the theoretical grounds of mural instability. Other uses suggested by these authors were as follows: Employment in the graded Estlander operation for chronic empyæma or bronchiectasis, to permit wider spacing of the stages and more prolonged collapse; use in the Brauer cardiolysis, to ensure permanent pliability of the præcordium; use in the rib resection for drainage of empyæma or lung abscess, to prevent new bone from forming in, and encroaching upon, the sinus; and use in the rib resection for cautery pneumectomy, to obviate the difficulty which may arise from regeneration of bone in the field of cauterization.

Neither one of the authors has reported clinical experience with his method, and the only reference of the kind that I can find is the bare statement of Trout³ that he had used the method of Head with satisfaction in thoracoplasty for pulmonary tuberculosis. I began to use Zenker's solution in plastic operations for chronic empyæma soon after the appearance of Head's publication, but changed later to formalin. Twelve cases of that type have been treated with one or the other chemical, and, besides, twenty-three cases with drainage of empyæma, three with drainage of lung abscess, and two with cautery pneumectomy. While this experience is quite insufficient for final evaluation of the methods, the results have been satisfactory and consistent enough to warrant preliminary report.

The first case to be treated was that of a white male, aged thirty-two years. At the time of admission to the hospital, he had been ill for eleven months with productive cough, fever, dyspnoea, and weakness. Five months before the symptoms had become so exaggerated that the patient had to stop work. His physician at the time made the diagnosis of empyæma of the left pleural cavity and established drainage by intercostal catheter. Considerable improvement followed, but soon the cough and fever returned. On admission the patient was found to be emaciated, weak, and toxic. The left half of the chest was markedly retracted and fixed, and it exhibited a narrow sinus at the seventh intercostal space in the posterior axillary line. Tubercle bacilli were abundant in the sputum and in the pus from the sinus. X-ray examination showed an empyæma cavity on the left side with very thick walls, extending from the third rib to the diaphragm and from the anterior axillary line to the vertebral column. An operation was done immediately to widen the sinus. A specimen of the pleura which was obtained at the time revealed the presence of tuberculous infection. The drainage thus established and the supportive treatment that followed produced great improvement of the constitutional condition within two months; but the cavity was unchanged in size, so the decision was made to obliterate it with the graded thoracoplasty of Schede. At the first stage, the lower one-third of the roof of the cavity was removed; but the shock was very severe. So, two months later, when the patient's strength was sufficiently restored, the milder operation of Estlander was resorted to, with the addition that the rib-free portions of periosteum were painted with Zenker's solution. The parts of the ribs lying over the cavity, together with a part of one rib (second) above, were removed in two sittings, with an interval of six weeks between to allow for delayed wound healing. The immediate effect of this was only partial obliteration of the empyæma cavity; but the collapse proved to be progressive and fourteen months after the last operation the cavity was closed, the sinus was healed, and the patient felt well.

In the three other cases of tuberculous empyæma treated since then, the entire lengths of the ribs overlying the cavities were removed subperiosteally

in small and widely spaced steps, with application of one or the other chemical to the periosteum. The cavities collapsed satisfactorily, and only one (see the case report below), which was operated upon very recently, has not yet healed. Graded subperiosteal resection of only the posterior segments of ribs was employed for the patients with extensive non-tuberculous empyæma. This included the ribs over the cavity—and one above if the cavity was subtotal. The result was that the anterolateral segments of ribs, the thickened parietal pleura, and the superficial tissues, which remained over the cavity, fell progressively during and after the operations until obliteration was complete. One of these cases required further work, to unroof a small residual cavity. Thus, in both types of empyæma, the Estlander operation almost entirely replaced the Schede procedure, which hitherto had been indispensable. Since the parietal pleura and intercostal structures were not removed, as in the Schede thoracoplasty, the operations were accompanied by relatively little blood loss and shock and by no paralysis of the abdominal wall. A comparatively small but noteworthy advantage of the chemical treatment was that, after resection of the posterior segments of ribs, the posterior ends of the anterolateral segments developed no spurs.* No appreciable disadvantage was experienced from paradoxical respiratory movements of the chest-wall. Scoliosis developed, but it was no greater—indeed, usually much less—than that after Schede resections for equally extensive cavities. Chemical poisoning was watched for but was not detected. Chronic empyæma cavities, which were so small as to extend under no more than three ribs, were still treated by the Schede thoracoplasty.

The expected benefits were derived, also, in connection with rib resection in the other types of cases. Although the benefits were comparatively slight, they were worth while.

One case was outstanding, because it made possible a direct comparison between Zenker's and formalin solutions as to their effectiveness in preventing osteogenesis.

A Chinese male, aged twenty-three years, was admitted to the hospital with a history of productive cough for two and one-half years. Slight weakness was the only accompanying symptom, until one day three months before when, during unusually strenuous coughing, sudden pain occurred in the right side of the chest and marked dyspnœa developed. He took to bed at once and soon had a chill and started to run a high fever. On admission the man was extremely emaciated and feeble, orthopnœic, cyanotic, and disturbed by a frequent productive cough. The sputum was fetid and contained myriads of tubercle bacilli. Physical and röntgenographical examination of the chest revealed complete collapse of the right lung, fluid and air in the right pleural cavity, extensive displacement of the mediastinum to the left, depression of the right hemidiaphragm, and a light infiltration of the left upper lobe which was suspected to be tuberculous. The chest was tapped. The fluid proved to be thick pus, containing tubercle bacilli, streptococci, staphylococci, and other organisms, and the air was found to be under pressure of plus 3 to 8 centimetres H₂O. The initial treatment consisted

* Hedblom¹ has emphasized the danger of laceration of the pleura and lung that exists during anterolateral costectomy for pulmonary tuberculosis, in removing ribs that carry these sharp, upward curved projections.

TREATMENT OF PERIOSTEUM IN THORACOPLASTY

in bi-daily aspiration of large quantities of pus and air and in general supportive measures. Within four weeks the dyspnoea was greatly relieved and the mediastinum was returned to the mid-position (Fig. 1); but the secondary infection and fever persisted, so that open drainage was done. At the same operation, ten centimetres of each of ribs 11, 10 and 9 were resected paravertebrally and the rib-free periosteum was painted with Zenker's solution, which constituted the first stage of an Estlander operation to de-rib the entire right half of the chest. The paravertebral wound became infected slightly from its close proximity to the drainage wound. The operation was well borne, nevertheless, so it was decided not to wait for complete healing of the paravertebral incision but to abandon the usual orderly progression of resection and operate the second time at a considerable distance. Consequently, the second stage was performed twenty-six days after the first and consisted in the resection of four to ten centimetres of the posterior extremities of ribs 4 to 1, inclusive, with application of Zenker's solution. The wound healed well. But shortly after this, the temperature became somewhat elevated, the cough increased, and a röntgenogram (Fig. 2) showed

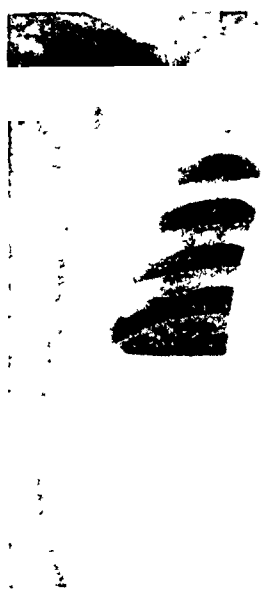


FIG. 1.



FIG. 2.

FIG. 1.—Thoracic röntgenogram of a case with secondarily infected, tuberculous empyema and complete collapse of one lung, taken just before the beginning of a graded subperiosteal costectomy wherein Zenker's and formalin solutions were compared for effectiveness in preventing rib regeneration.

FIG. 2.—Same case, thirty-six days after the establishment of open drainage and the resection of the posterior segments of ribs 11 to 9, and ten days after the resection of the posterior segments of ribs 4 to 1. The rib-free periosteum was painted with Zenker's solution. Arrows indicate the foci of new bone from the first operation.

a slight increase in the lesion of the left lung. The same röntgenogram was interesting from the fact that it gave an exceptionally distinct view of the beds of some of the resected ribs—due to the persistence of a bridge of ribs (8 to 5) across the middle of the hemithorax which held the beds widely out—and that it showed definite traces of new bone in the field of the first operation performed thirty-six days previously. The infection in the left lung quieted sufficiently to permit the third stage to be performed fifty-one days after the second, with removal of the anterolateral segments of the upper four ribs; but this time 10 per cent. solution of formalin was used in place of Zenker's solution, according to Meiss' suggestion. The wound healed *per primam*. And once more the condition of the left lung demanded a long wait. A röntgen-film (Fig. 3), taken fifty days after the third stage, showed that the formalin-treated periosteum was free from appreciable amounts of new bone, while the Zenker's treated periosteum of the first operation (127 days before) had developed incomplete but well-defined ribs. The field of the second operation lay too close to the spine to permit clear

discernment of the degree of rib regeneration. The fourth operation came the day after this examination and the fifth came twenty-seven days later, whereby the remaining ribs and portions of ribs were taken out and the periosteum was painted with formalin. Figure 4 gives the appearance ten days after the last operation when the chest-wall was completely collapsed and the merest slit remained of the empyæma cavity. The patient's condition was satisfactory in other respects, also. The cough was absent, the temperature normal, the pulse rate only slightly elevated, and the body weight increased by four kilograms. The lesion of the left lung seemed about the same as at admission. A prolonged period of rest was then indicated, to permit that infection and the one in the collapsed empyæma cavity to heal, but the prognosis was fair.

The results in this case suggest that formalin is much more effective than Zenker's solution. In view of the fact that the collapse of the chest was complete, both in this and in the other cases treated with Zenker's solution, it is very likely that the ribs which regenerated after the use of that agent were



FIG. 3.

FIG. 4.

FIG. 3.—Same case, fifty days after the resection of the anterolateral segments of ribs 4 to 1 with application of formalin solution (third costectomy). No new bone is visible. Arrows indicate the enlarged, fragmentary deposits of bone 127 days after the first operation.

FIG. 4.—Same case, five months and five days after the first and ten days after the last (fifth) costectomy. Ribs 11 to 1 are absent and the empyæma cavity is totally collapsed.

fragmentary rather than solid. Although formalin seemed to prevent osteogenesis entirely in the instance cited above, proof has since appeared that it permits a slight amount of bone to form. In a case being treated at present by cautery pneumectomy, the slough of the thoracic wall from the first burning contained tiny spicules of bone along the lines of the periosteal beds which had been stripped of ribs and painted with formalin thirty-six days before the burning. The partial regeneration that occurs after both agents probably accounts for the satisfactory degree of stability of the chest-wall that resulted in all of the cases of chronic empyæma. Furthermore, it suggests that the method of periosteal treatment can be applied to paravertebral thoracoplasty for pulmonary tuberculosis without danger of instability of the thorax. This will soon be tested, first with Zenker's solution.

The solutions were applied as follows. After each rib was removed, its

TREATMENT OF PERIOSTEUM IN THORACOPLASTY

periosteum was sponged free from blood and then wiped throughout with a small gauze swab, which had been dipped in the solution and shaken out. The periosteum was again sponged dry and painted with a fresh swab; and the process was repeated five or six times. This insured that the rib bed received thorough contact with the agent, without much contamination of the surrounding tissues.

SUMMARY.—The discoveries of Head and Meiss are recounted, that bone regeneration after subperiosteal costectomy in dogs can be prevented completely by application to the periosteum of Zenker's or formalin solution, as well as the suggestions of these authors as to possible clinical applications. Personal experience with both agents for this purpose is briefly reported, which concerned forty-three clinical cases, including twelve with chronic empyæma. It is concluded that, in man, both solutions inhibit the reformation of bone markedly but do not prevent it entirely, that formalin is much the more effective, and that the use of one or the other of these chemicals is advantageous in certain operations of rib resection. The chief advantages occur in the treatment of large chronic empyæma cavities, because the Estlander thoracoplasty can be used in place of the more destructive and shock-producing procedure of Schede, the stages of resection can be placed as far apart as desired, spurs do not form on the ribs, the chest-wall continues to collapse long after the last operation.

BIBLIOGRAPHY

- ¹Head, J.: Prevention of Regeneration of the Ribs. A Problem in Thoracic Surgery. Arch. Surg., vol. xiv, p. 1209, 1927.
- ²Meiss, W.: Experimenteller Beitrag zur Vereinfachung der Thoracoplastik in mehreren Tempi. Zentralbl. f. Chir., vol. lvii, p. 349, 1930.
- ³Trout, H.: The Release of Pericardial Adhesions. Arch. Surg., vol. xxiii, p. 966, 1931.
- ⁴Hedblom, C.: Anterolateral Costectomy for Inadequate Collapse Following Posterior Extrapleural Thoracoplasty. Arch. Surg., vol. xxi, p. 1114, 1930.

LONGITUDINAL BONE GROWTH

THE INFLUENCE OF SYMPATHETIC DEINNERVATION

BY J. DEWEY BISGARD, M.D.

OF CHICAGO, ILL.

FROM THE DEPARTMENT OF SURGERY OF UNIVERSITY OF CHICAGO, DIVISION OF ORTHOPÆDIC SURGERY

SINCE disturbances of the normal longitudinal growth of bone frequently result in disabling discrepancies in the length of the extremities, they command considerable clinical importance. Especially is this true of the lower extremities in which a disproportion of more than $1\frac{1}{2}$ inches produces a limp, a functional scoliosis and ultimately, in a fair proportion of cases, a painful traumatic arthritis.

To be differentiated from this group are the discrepancies resulting from (1) congenital deformations; (2) loss of bony substance in comminuted fractures and from aseptic and septic necrosis, tumor invasion, *etc.*; and (3) a break in continuity with overlapping of the fragments (traumatic and pathological fractures).

Disturbances in longitudinal bone growth are caused by a large group of conditions which alter the normal physiological process of ossification within the epiphyseal cartilages, and upon this basis may be grouped into five general classes:

(1) Complete or partial destruction of an epiphyseal cartilage may occur in such conditions as bone and joint tuberculosis, osteomyelitis, and new growths.

(2) Premature closure by ossification occasionally results from traumatic epiphyseal separation, damage at operation, and certain obscure growth disturbances such as dyschondroplasia.

(3) Accelerated activity not infrequently obtains in conditions that bring about an increased blood supply to this portion of bone such as adjacent pyogenic and tuberculous bone and joint infections, neighboring neoplasms and arteriovenous aneurisms. Among the more rare and obscure entities may be mentioned dyschondroplasia, gigantism, and dyspituitarism.

(4) Irregularities in the rate of growth may occur in portions of the same epiphyseal line producing curvatures of contour (valgus or varus deformities). A discrepancy in the growth of two parallel bones such as the radius and ulna may distort their respective relationships and articular extremities. Examples of these phenomena occur with partial destruction of the epiphyseal cartilage by infection or trauma and in such conditions as multiple cartilaginous exostoses and dyschondroplasia.

(5) Retarded activity is observed as a result of prolonged disuse from any cause. It occurs in chronic bone and joint disease, in certain neuropathical disturbances (notably residual paralysis of anterior poliomyelitis),

LONGITUDINAL BONE GROWTH

in congenital lesions (dyschondroplasia, syphilis) and in certain metabolic disturbances (rickets, cretinism).

In the consideration of treatment of this latter group the possibility of devising a method to bring about an acceleration of bone growth in the short extremity has led to speculation. Clinical and experimental observations in recent years have demonstrated quite conclusively that the interruption of the sympathetic innervation of an extremity removes the function of vasoconstriction and results in at least a temporary vasodilatation. The frequent observation of accelerated growth activity in an epiphysis in close proximity to a chronic inflammatory process (presumably the result of an increased blood supply) led quite naturally to the assumption that sympathetic deinnervation might have a similar effect. This deductive reasoning found application in a case reported by Harris in November, 1930. He states that two years following the interruption of the sympathetic nerve supply of the left leg with a pre-operative shortening of $1\frac{1}{2}$ inches as a result of retarded growth from residual paralysis of anterior poliomyelitis, there was a reduction in this discrepancy of three-quarter inches.

Experimental investigation, however, has failed to corroborate this clinical observation. Cannon and his co-workers have removed the entire sympathetic chain on one side of the body of kittens and infant rats (Bacq) and have observed no increase in growth on the sympathectomized side of the component structures of the extremities, the bilaterally symmetrical soft tissues and viscera with the exception of the reproductive organs. René Simon obtained the same results with rabbits.

These investigators apparently read the results of their experiments only at the conclusion of the growth period, that is, at post-mortem examination. To preclude the possibility of a temporary acceleration of bone growth at some stage in development, the following experiments were carried out. The left lumbar sympathetic ganglia and intervening trunks were removed from four kid goats and semimonthly measurements by X-ray examinations were made of both tibiae.

EXPERIMENTAL OBSERVATIONS

Experiment I.—Goat 2 (W). Approximate age six weeks; weight 6.0 kilograms.

Pre-operative X-rays in lateral views of both lower extremities the right tibia measured 13.6 centimetres, the left tibia 13.6 centimetres.

Operation.—April 27, 1931, morphine and ether anaesthesia. With an exposure through a mid-line abdominal incision the loops of small intestine and the sigmoid were retracted medialward. The posterior parietal peritoneal reflection immediately lateral to the sigmoid was incised and the retroperitoneal space entered. By sweeping the parietal peritoneum medially with blunt dissection, the left lumbar sympathetic trunk and ganglia were exposed. The left lumbar ganglia 2, 3, 4, and 5 and intervening trunks were excised and the defect in the parietal peritoneum closed. By entering the retroperitoneal space lateral to the caecum the right lumbar chain was exposed but left undisturbed. This was carried out merely as a control procedure.

Surface temperature readings of the lower extremities immediately after operation were: left 32.8°C ., and right 30.6°C . By palpation this difference was definitely discernible.

This animal was observed for eight months and both tibiae were measured by X-ray examination every two weeks during the first four months and at monthly intervals thereafter. The X-ray pictures at the beginning and at the termination of the experiment

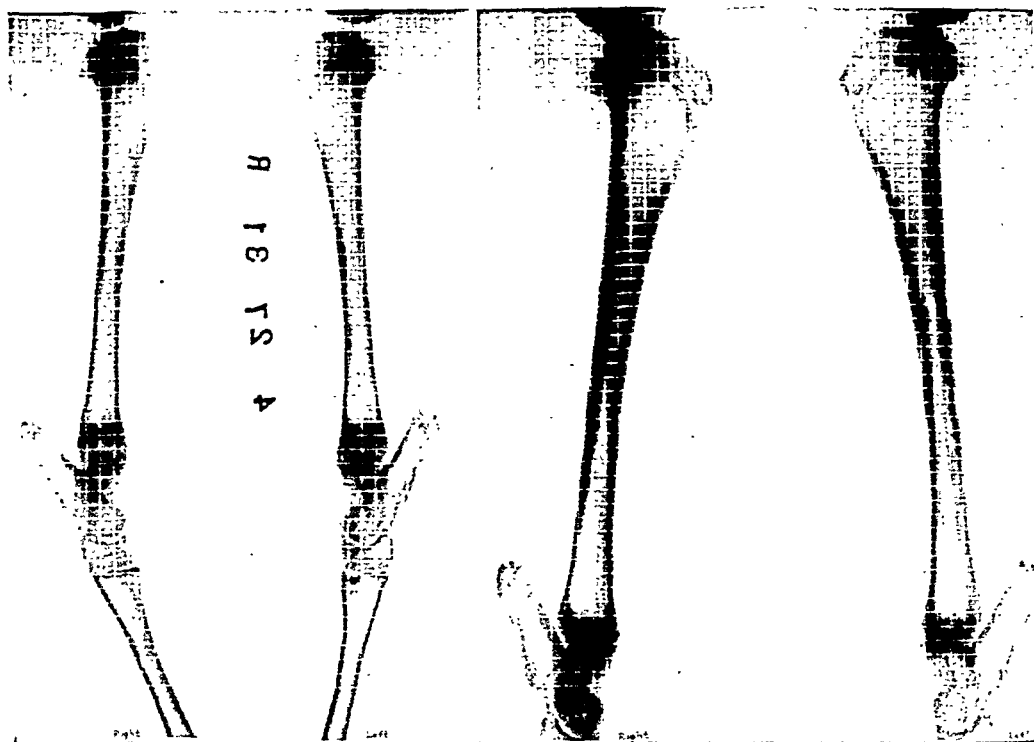


FIG. 1.

FIG. 2.

FIG. 1.—Röntgenogram of both tibiae of Goat II on day of operation. Both tibiae are of equal length, measuring 13.6 centimetres.

FIG. 2.—Tibiae of same animal represented in Fig. 1, seven and one-half months after a left lumbar sympathetic ganglionectomy. Note that they are of equal length. The longitudinal growth during this period was 6.5 centimetres in each tibia.

are represented in Figs. 1 and 2. In Table I the periodic measurements and body weights are recorded.

TABLE I

Goat I

| Date | Body Weight in Kilograms | Length of Right Tibia (Normal Extremity) in Cms. | Length of Left Tibia (Sympathecto- mized Extremity) in Cms. |
|---------------------|--------------------------------|--|---|
| Apr. 27, 1931..... | 6.0 | 13.6 | 13.6 |
| May 10, 1931..... | 5.8 | 14.0 | 14.0 |
| May 25, 1931..... | 8.5 | 15.0 | 14.9 |
| June 10, 1931..... | 11.0 | 15.8 | 15.8 |
| June 27, 1931..... | 14.2 | 16.2 | 16.2 |
| July 11, 1931..... | 15.5 | 16.6 | 16.6 |
| July 26, 1931..... | 18.2 | 17.2 | 17.3 |
| Aug. 12, 1931..... | 19.5 | 18.0 | 18.0 |
| Sept. 10, 1931..... | 20.0 | 18.6 | 18.7 |
| Oct. 8, 1931..... | 21.2 | 19.0 | 19.0 |
| Nov. 5, 1931..... | 22.4 | 19.7 | 19.7 |
| Dec. 7, 1931..... | 23.0 | 20.1 | 20.1 |

Experiments II, III, and IV.—Goat 3. Approximate age six weeks; weight 5.8 kilograms. Operation, April 27, 1931.

LONGITUDINAL BONE GROWTH

Goat 4. Approximate age six weeks; weight 5.0 kilograms. Operation, April 29, 1931.

Goat 8. Approximate age six weeks; weight 6.2 kilograms. Operation, May 4, 1931.

Precisely the same operative procedures and observations as described in Experiment I were carried out on these three animals and in each instance the interruption of the sympathetic innervation was verified by the higher surface temperature readings (approximately 2° C.) in the sympathectomized extremities. The weights and measurements are recorded in condensed form in Table II.

TABLE II

| Date | Body Weight in Kilograms | Length of Right Tibia (Normal Extremity) in Cms. | Length of Left Tibia (Sympathecto- mized Extremity) in Cms. |
|--------------------|--------------------------------|--|---|
| Goat 2 | | | |
| Apr. 27, 1931..... | 5.8 | 13.3 | 13.4 |
| July 23, 1931..... | 16.3 | 17.4 | 17.4 |
| Dec. 7, 1931..... | 22.6 | 19.8 | 19.8 |
| Goat 6 | | | |
| Apr. 29, 1931..... | 5.0 | 13.2 | 13.2 |
| July 23, 1931..... | 14.8 | 17.2 | 17.2 |
| Dec. 7, 1931..... | 20.8 | 20.0 | 20.0 |
| Goat 8 | | | |
| May 4, 1931..... | 6.2 | 13.5 | 13.5 |
| July 23, 1931..... | 15.0 | 18.0 | 18.1 |
| Dec. 7, 1931..... | 24.2 | 20.2 | 20.1 |

To these experiments the objection can be raised that they were conducted upon normal animals and to overcome this objection a parallel experiment to the human cases of shortening resulting from infantile paralysis was sought. From Doctor Hudson, of the Department of Bacteriology of the University of Chicago, a half-grown monkey with open epiphyseal lines and complete symmetrical residual paralysis of both lower extremities with contractures from anterior poliomyelitis was obtained. The infrequent occurrence of this distribution of the paralysis in "polio monkeys" limited the experiment to this one animal.

Experiment V.—Monkey No. 519; weight 1.6 kilograms, operation July 17, 1931. A left lumbar sympathetic ganglionectomy was carried out with the technic described in Experiment I. After operation the left lower extremity was definitely warmer than the right. The subsequent measurements of both tibiae are recorded in Table III.

TABLE III

Monkey No. 519

| Date | Body Weight in Kilograms | Length of Right Tibia (Normal Extremity) in Cms. | Length of Left Tibia (Sympathecto- mized Extremity) in Cms. |
|---------------------|--------------------------------|--|---|
| July 17, 1931..... | 1.6 | 10.2 | 10.2 |
| Aug. 10, 1931..... | 1.5 | 10.3 | 10.3 |
| Sept. 14, 1931..... | — | 10.4 | 10.4 |
| Oct. 15, 1931..... | — | 10.45 | 10.45 |
| Nov. 12, 1931..... | 2.0 | 10.5 | 10.5 |
| Dec. 12, 1931..... | — | 10.55 | 10.55 |
| Jan. 14, 1932..... | 2.2 | 10.6 | 10.6 |

The photograph, Fig. 3, was taken with the animal in motion to record the dragging of the paralyzed lower extremities.



FIG. 3.—Monkey No. 519. Animal in motion. Note dragging of both paralyzed lower extremities.

Figs. 4 and 5 represent the X-ray findings at the beginning and termination of the experiment.

Comment.—The effect of sympathetic deinnervation upon longitudinal bone growth has been studied in four normal kid goats and in one monkey

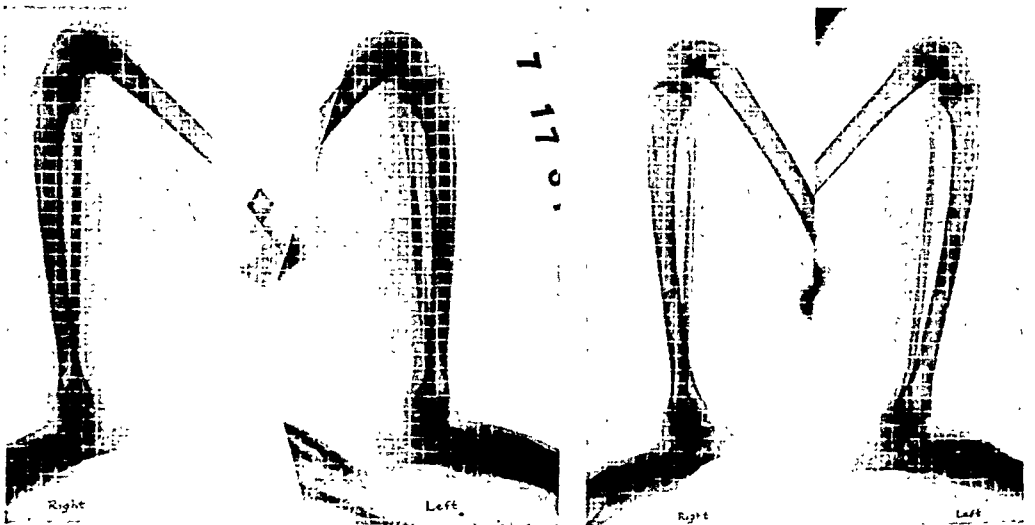


FIG. 4.

FIG. 5.

FIG. 4.—Radiogram of tibiae of "polio monkey" (Fig. 3) taken on the day of operation. Both tibiae measured 10.2 centimetres.

FIG. 5.—Radiographical measurements (same animal in Fig. 4) six months after a left lumbar sympathetic ganglionectomy. Both tibiae show equal longitudinal growth, 0.4 centimetres.

with complete symmetrical residual paralysis of both lower extremities from anterior poliomyelitis. In each instance the left hind leg was deinner-

LONGITUDINAL BONE GROWTH

vated of its sympathetic nerve supply and the right one used for control measurements.

The four goats were observed for eight months and during this period their weights quadrupled and the tibiae on both sides increased in length approximately 6.5 centimetres. Semi-monthly measurements by X-ray examination, however, have demonstrated that the tibiae on the sympathectomized sides have at no time evidenced an accelerated rate of growth as compared to the normally innervated extremities.

The "polio monkey" was observed for six months. During this period both tibiae increased 0.4 centimetres in length and at no time was there evidence of an acceleration of longitudinal bone growth.

From the results of this investigation it is reasonable to conclude that the longitudinal growth of bone was in no way influenced by the removal of its sympathetic nerve supply, either in otherwise normally innervated extremities or in the extremity paralyzed as a result of anterior poliomyelitis. Consequently, there appears to be no experimental evidence to justify the use of this operation in the hope of correcting discrepancies in the length of the extremities by accelerating delayed longitudinal bone growth. The surgical treatment of cases with length asymetry regardless of cause invokes the application of one of three principles: (1) Shortening of the long extremity, (2) lengthening of the short leg, and (3) complete or partial arrestment of growth in the long extremity.

(1) Jacob Von Heine has been credited with the first surgical attempts to correct length disproportions in the lower extremities. In 1840, he reported an operation for the shortening of the long leg. With variations in technical details this operation has been used considerably and the results, although functionally gratifying, have the obvious objectionable feature of shortening the stature of the patient.

(2) In 1905, Codivilla described a method for lengthening the short extremity and reported twenty-two cases with a gain in length varying from three to eight centimetres. This method and its modifications in recent years by Putti, Freiberg, Magnuson, Ombrédanne, Taylor, Fassett, Lambert, Steinman, Hey-Groves, Abbott, Carrel, and others involve the principle of distraction of the fragments of the osteotomized femur or tibia. The main contributions from these modifications have made it possible to control the fragments in alignment and apposition during the period of gradual skeletal distraction. Anatomically, the principle of this operation is ideal but it carries with it the hazards of an extensive operation and the technical difficulties involved in the post-operative lengthening procedure.

(3) Recently, Phemister reported a method for arrestment of longitudinal bone growth by bridging the epiphyseal line with bone grafts. Within a few weeks the epiphyseal line becomes obliterated. With a knowledge of the rate and proportion of growth from the various epiphyseal lines, it is possible by arresting growth in one or more epiphyseal cartilages at the proper time (in respect to age) to retard growth in the long extremity sufficiently to give the short one an opportunity to overcome all or part of the length discrepancy. This operation affords the advantage of a simple non-shocking procedure, but its application is limited to the period of growth.

CONCLUSIONS.—(1) In normal experimental animals longitudinal bone growth is not influenced by sympathetic deinnervation.

(2) Retarded bone growth in a monkey with residual paralysis from anterior poliomyelitis was not accelerated by sympathetic deinnervation.

(3) There is no experimental evidence to justify the use of the operation of sympathetic ganglionectomy for the purpose of accelerating bone growth.

(4) The three tried and proved methods of correction of length discrepancies of the extremities are: (1) Shortening of the long extremity by osteotomy, (2) longitudinal growth arrestment of the long extremity and (3) lengthening the short extremity by distraction.

BIBLIOGRAPHY

- ¹ Abbott, L. C.: The Operative Lengthening of the Tibia and Fibula. J.B.J.S., vol. ix, pp. 128-152, 1927.
- ² *Idem*: Operative Lengthening of the Tibia and Fibula. West. Jour. Surg., vol. xxxix, pp. 513-519, July, 1931.
- ³ Abbott, L. C., and Crego, C. H.: Operative Lengthening of Femur. South. Med. Jour., vol. xxi, pp. 823-832, 1928.
- ⁴ Bacq, Z. M.: Action of Abdominal Sympathectomy on Growth of Albino Rat and Weight of Genital Organs. Am. Jour. Physiol., vol. xcv, pp. 601-604, 1930.
- ⁵ Cannon, W. B., Newton, H. F., Bright, E. M.: Some Aspects of Physiology of Animals Surviving Complete Exclusion of Sympathetic Nerve Impulses. Am. Jour. Physiol., vol. lxxxix, pp. 84-107, 1929.
- ⁶ Carrel, W. B.: Leg Lengthening. South. Med. Jour., vol. xxii, pp. 216-221, 1929.
- ⁷ Codivilla, A.: On the Means of Lengthening in the Lower Limbs, the Muscles and Tissues Which Are Shortened Through Deformity. Am. Jour. Orth. Surg., vol. ii, p. 353, 1905.
- ⁸ Fassett, F. J.: An Inquiry as to the Practicability of Equalizing Unequal Legs by Operation. Am. Jour. Orth. Surg., vol. xvi, p. 277, 1918.
- ⁹ Freiberg, A. H.: Codivilla's Method of Lengthening the Lower Extremities. Surg., Gynec., and Obst., vol. xiv, p. 614, 1912.
- ¹⁰ Harris, R. I.: Effect of Lumbar Sympathectomy on Growth of Legs Shortened from Anterior Poliomyelitis; Preliminary Report. J.B.J.S., vol. xii, pp. 859-866, 1930.
- ¹¹ Heine, J. von: Beobachtungen über Lahmungszustände der unteren Extremitäten und deren Behandlung. F. H. Kohler, Stuttgart, 1840.
- ¹² Jansen, M.: Dissociation of Bone Growth, The Robert Jones Birthday Volume, pp. 43-73, Oxford University Press, 1928.
- ¹³ Magnuson, P. B.: Approximation of the Ends of Fragments in Fractures with Contraction of the Attached Muscles. ANNALS OF SURGERY, vol. liv, p. 227, 1911.
- ¹⁴ *Idem*: Lengthening Shortened Bones of the Leg by Operation, Surg., Gynec., and Obst., vol. xvii, p. 63, 1913.
- ¹⁵ Ombredanne, L.: Allongement d' un Femur, sur un Membre Trop Court. Bull. et Mem. Soc. de Chir. de Paris, vol. xxxix, p. 1177, 1913.
- ¹⁶ Phemister, D. B.: Personal Communication.
- ¹⁷ Putti, V.: The Operative Lengthening of the Femur. Jour. Am. Med. Assn., vol. lxxvii, p. 934, 1921.
- ¹⁸ Steinman, F.: Eine neue Extensionsmethode in der Fracturenbehandlung. Zentralbl. f. Chir., vol. xxxiv, p. 938, 1907.
- ¹⁹ Simon, R.: Innervation Sympathique et Croissance. Compt. Rend. Soc. Biol., vol. ciii, p. 709, 1930.
- ²⁰ Taylor, R. T.: Shortening Long Legs and Lengthening Short Legs; A New Surgical Procedure. Am. Jour. Orth. Surg., vol. xiv, p. 598, 1916.

INTERSCAPULO-THORACIC AMPUTATION FOR SECONDARILY INFECTED TUBERCULOSIS OF SHOULDER

BY HENRY MILCH, M.D.

OF NEW YORK, N.Y.

FROM THE SERVICE OF DR. H. FINKELSTEIN AT THE HOSPITAL FOR JOINT DISEASES

FOR the most part the indications for interscapulo-thoracic amputations have been extensive injuries or malignant disease about the shoulder-joint. In such cases the performance of this huge operation and the sacrifice of the whole of the upper extremity has been considered of small import in face of the urgent necessity of saving life. In a very small percentage of cases the procedure has been employed in the treatment of large benign tumors about the upper extremity, as in the case of a large chondroma of the humerus reported by Spickers (*Journal Med. Soc. of New Jersey*, vol. xxii, p. 283, 1925).

Though I have been unable to examine a complete list of all the cases heretofore reported, it appears to have been only relatively seldom used, if at all, in cases of severe infections involving the shoulder-joint.

It is, of course, not my intention to advocate the more extensive use of this tremendous operation in every case of even severe infection about the shoulder-joint. Rather, I hope to direct to the attention of others, as it was called to my attention, that this operation should be at least considered in cases which offer no hope of satisfactory solution by any of the more conservative procedures. In the case herewith presented, no question of malignancy arose and the operation was undertaken solely with the purpose of eradicating an infection which had persisted for several years and which was rapidly leading the patient down hill. It is my belief that in this particular case the operation was life-saving and was amply warranted by the condition of the patient, as well as by its successful outcome.

P. M., male, age thirty-seven, cook; was first seen April 6, 1931, complaining of pain, limitation of motion, and numerous sinuses, from all of which pus issued copiously, completely encircling the right shoulder-joint. The patient first began to have trouble January 18, 1929, when while at work he suffered a severe jerk to his right shoulder, and though he immediately complained of pain, continued at his work. About one week later, because the pain was growing progressively worse, he was seen by his family physician, who could find nothing to account for his symptoms. Twenty-four hours after the onset, however, the condition became so aggravated that the patient, no longer able to continue his labors, was confined to bed. Swelling appeared over the anterior region over the shoulder-joint, there was a marked increase in local heat, the arm became fixed to the side, and attempts at motion of the arm in any direction were extremely painful. The patient was treated conservatively for several months, and finally was admitted to one of the hospitals in the city, where he remained from June to December, 1929. A pre-operative diagnosis of osteomyelitis of the shoulder was made, and "four major operations and numerous incisions and drainage were performed." Pathological material removed during the course of these operations subsequently established the

diagnosis of tuberculosis of the shoulder. In December, 1929, he was discharged from the hospital with multiple sinuses surrounding the shoulder-joint. In February of 1930 he was seen at one of the city hospitals and was thence sent to a city tuberculosis institution, where he remained from March until November, 1930, undergoing conservative treatment. Between the time of his discharge from the last hospital and the time of his first visit to me, he was seen and studied for short periods of time in several other hospitals, at which he was advised against submitting to any further operations.

During this time the patient constantly ran an afternoon temperature and had such severe pain that he never enjoyed a night's rest. Within the four months prior to his examination by me, he had lost about thirty-five pounds in weight.

On admission to the Hospital for Joint Diseases in April, 1931, the patient presented the appearance of a normally developed, markedly undernourished man, not in



FIG. 1.—Infected shoulder tuberculosis requiring interscapulo-thoracic amputation.

severe pain, but obviously chronically ill. His shoulder-joint was surrounded by a number of sinuses of varying size, from which a dirty, yellowish-gray pus was discharging. (Fig. 1.) The arm was atrophic, fixed at the side, and permitted of only a few degrees of passive motion. The spleen was enlarged to about two fingers below the costal margin.

Smears from the wound showed many pus cells. *Staphylococcus aureus* was grown on culture. The Wassermann test was negative. The blood count showed 3,520,000 red blood cells, 70 per cent. hæmoglobin, 17,500 white blood cells; 63 per cent. neutrophiles, 10 per cent. eosinophiles, 25 per cent. lymphocytes and 2 per cent. mononuclears, with toxic appearance of polymorphonuclears. The stool examination was negative for ova and parasites. The urine showed nothing unusual. The quantitative tuberculin test was strongly positive. The chest was carefully examined by the phthysiologist (Doctor Wiener), who found "no evidence of any active clinical pulmonary tuberculosis. There is a leathery type of friction sound heard in the axillary region on the right side, probably due to old pleurisy. The heart sounds are good and clear. Patient can unquestionably stand a general anæsthetic." X-rays of the right shoulder girdle (Fig. 2)

INTERSCAPULO-THORACIC AMPUTATION

were reported by Doctor Pomerantz as showing "the shoulder-joint completely obliterated. The margins of the glenoid fossa show irregular erosion. The scapula below the glenoid fossa shows irregular erosion, and cortical bone production. There is some osteoplastic bone production about the coracoid process. The head of the humerus is extremely atrophic and irregularly eroded. Externally, there is a linear calcification probably within the bursa. The neck of the humerus shows active destruction. The cortex and the periosteum at the proximal third show fairly symmetrical thickening. The soft parts about the shoulder-joint show irregular excavations, probably the site of sinuses. *Conclusion.*—Osteomyelitis of the humerus and scapula, with an old pyarthrosis of the shoulder-joint."

In discussing the case with the röntgenologist, I was assured that the presence of a secondary infection would so change the röntgenographic appearance that the typical



FIG. 2.—Skiagraph of infected tuberculous shoulder.

picture of tuberculosis might be completely unrecognizable. However, in the face of a positive pathological report from the hospital where the patient was originally operated on, and positive quantitative tuberculosis tests at our own hospital, I felt that I was justified in considering this as a case of tuberculosis of the shoulder with secondary infection. At first sight, the condition of this patient's right shoulder was so appalling that I was at quite a loss to know exactly what to do. Practically every surgeon who entered within the walls of the hospital was literally dragged in to see this patient and to render an opinion. The opinions received varied in nature from complete conservatism to radical amputation. On first thought, radical amputation appeared to be somewhat too extensive a procedure, and an attempt was made to treat the patient conservatively by immobilizing the arm in a plaster bandage. Subsequently, April 16, 1931, under general anaesthesia an effort was made to gradually abduct the humerus of the shoulder-joint so as to overcome the abduction contracture. In spite of extremely gentle manipu-

lation, the shoulder had been abducted a matter of only fifteen degrees, when a soft yielding rather than a snap was felt, and it was realized that a fracture of the humerus had been produced. This was subsequently confirmed by X-rays. Hesitancy at performing an interscapulo-thoracic amputation was now completely dissipated, and the problem was put squarely before the patient and his family for decision. They were apparently less timid of the outcome and eagerly, indeed joyously, embraced, even at the risk of death, the opportunity of being relieved of an extremity that had been completely useless, as well as a source of constant pain, during a period of two and one-half years.

April 21, preliminary to operation, 600 cubic centimetres of whole blood were transfused by the Unger method, and on the following day a typical interscapulo-thoracic amputation was performed with the kindly and invaluable assistance of Dr. Harold Neuhoff, who had originally advised this procedure.

A four-inch incision was made along the middle of the right clavicle and the clavicle was exposed subperiosteally. A Gigli saw was passed subperiosteally, and the clavicle divided at the junction of its middle and inner thirds. The outer portion of the clavicle was now widely retracted outward, the subclavian vessels and brachial plexus exposed, and the subclavian artery doubly ligated and cut across in its third portion. In attempting to ligate the subclavian vein, a small rent developed proximal to the ligature, necessitating the further resection of about one inch of the inner fragment of the clavicle. The vein was thereupon successfully ligated with No. 3 chromic catgut and divided. The three trunks of the brachial plexus were infiltrated with 95 per cent. alcohol and were divided with perfect hæmostasis. The pectoral muscles were then exposed through a racquet incision, which encircled the axilla, and both major and minor muscles were cut across. With the division of the pectoral muscles, the upper extremity became freely movable. The patient was now turned to the left side and the posterior skin flap raised from the skin incision. The trapezius was divided and the arm pulled forward, making the elevator scapulæ and rhomboid muscles tense. These were divided close to their insertion at the scapula, exposing the serratus magnus and latissimus dorsi, which were similarly cut across. The extremity now remained attached to the body by the omohyoid and the subcutaneous tissues, which were rapidly cut across, after tying their vessels. The cut ends of the muscles were sutured to the chest wall with interrupted plain catgut sutures and the skin was approximated with several interrupted silkworm gut sutures, which allowed drainage throughout the entire wound. Two rubber dam drains were inserted, one emerging from the lower end of the wound and one from the middle of the wound, and a large, dry compression bandage applied. During the entire operation, the patient received about 1,100 cubic centimetres of an intravenous infusion of glucose 5 per cent. in saline, by the continuous drip method. During the whole operation, only a relatively slight amount of blood was lost, because of the excellent hæmostasis afforded by preliminary ligation of the vessels. Although in very mild shock on leaving the operating room, the patient's condition was considered extremely satisfactory, the pulse being 116, and of good quality.

Following operation, the patient made a remarkably uneventful recovery. The post-operative shock was so completely combated, that on the second post-operative day, the patient was anxious to be up and about, but our fears for the integrity of the subclavian ligatures prompted us to keep him in bed. On April 24 transfusion of 500 cubic centimetres of whole blood with the Unger method was carried out, more for the purpose of giving the patient a good start toward convalescence than because of any specific indications. The convalescence was completely uneventful. On the ninth day, the patient was permitted to sit up in bed, and on the eleventh day was walking about the ward. (Fig. 3.) One month later the wound was so far healed that a prosthetic appliance could be fitted to the patient. (Fig. 4.) Shortly after applying this apparatus, however, several small fistulous tracts reappeared along the line of the incision. In spite of their appearance, the patient was discharged seven weeks after operation for ambulant

INTERSCAPULO-THORACIC AMPUTATION

treatment. These sinuses were lined by white gelatinous appearing, unhealthy granulation tissue, which yielded slowly only to the topical application of caustic silver nitrate.

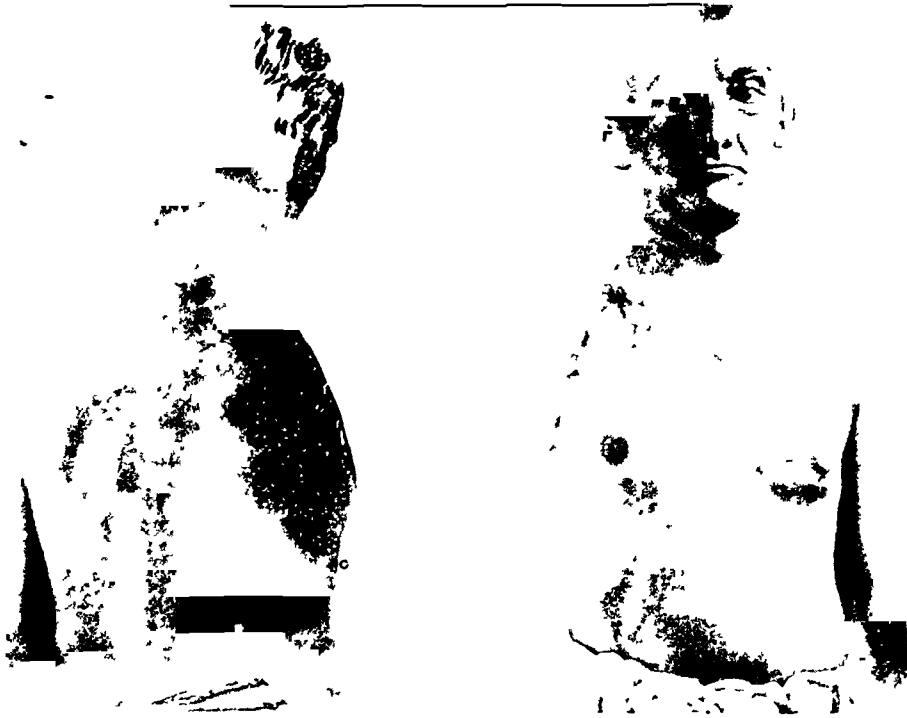


FIG 3 — Interscapulo thoracic amputation

Since operation, the patient has been able to pursue his normal existence, free from pain and temperature. He has now (February, 1932) returned to somewhat more than his original normal weight, despite the loss of the upper extremity.



FIG 4.—Prosthetic appliance after interscapulo thoracic amputation

The whole upper extremity was sent to the laboratory for examination, and Doctor Jaffe, the pathologist, subsequently reported:

"Gross.—Specimen consists of the whole *right* upper extremity, including the scapula. The arm and portion of the shoulder are swollen. There are a number of sinus tracts oozing pus in the arm. On hemi-section of the specimen, large numbers of abscess tracts are found between the muscle groups. There is a transverse fracture at the junction of the upper and middle thirds of the humerus. The narrow cavity of the humerus contains a large amount of hæmorrhagic soft material, which was removed for section. Part of the specimen was macerated and showed a transverse fracture, as described above, with no evidence of healing. There is a slight cortical thickening on one surface, but the other surface shows marked cortical atrophy. The entire humerus shows atrophy. The articular cartilage of the head of the humerus is destroyed. The acromion of the scapula shows an osteomyelitis and the rest of the scapula is extremely atrophic.

"Microscopical.—Sections show a very extensive necrotizing inflammatory process, with some of the sections showing a few giant cells and tubercle-like processes. A careful search for tubercle bacilli failed to disclose the presence of any in the tissue sectioned."

Though I realize that the limited experience gained by this case does not entitle me to speak in general terms of this operation, still I feel that in view of the extreme rarity with which this operation is performed, even casual observations may be of some value. In the first place, I feel that both pre-operative, and, if necessary, post-operative transfusions, as well as infusion of glucose saline during the course of the operation, are of the utmost moment in combating the shock of so extensive an operation. This is considered of such value that it is almost of routine nature in all cases of major magnitude treated at our hospital. In performing the operation, some have advised ligating the vessels after the extremity has been almost completely amputated from behind. It is my opinion that preliminary ligation of the vessels is desirable, since it permits of operating in a relatively blood-free field and relieves the operator of considerable anxiety. However, as I review the steps in the operative technic employed on this patient, I have the feeling that a great deal of difficulty might have been avoided had ligation of the artery not been attempted directly at the outset. Early in the operation, despite the severance of the clavicle, the vessels are approached with some difficulty, because of their position in the depths of the wound. If, however, after division of the clavicle, the pectoral muscles be cut across, the whole of the shoulder girdle can be gently pushed back, disclosing the subclavian vessels and the brachial plexus, and rendering their approach for surgical treatment much more felicitous.

RECURRING EXTERNAL DISLOCATIONS OF THE PATELLA *

By B. FRANKLIN BUZBY, M.D.

OF CAMDEN, N. J.

THE causes of recurring external dislocations of the patella may be divided into three, according to Jones and Lovett: (1) congenital; (2) traumatic; and (3) rachitic. Structural or mechanical would be a more inclusive term for the latter. (1) Congenital cases are those where the patella is small and permanently upwardly, as well as outwardly, displaced. (2) Traumatic cases are those where, following one severe, rather crippling injury accompanied by a rupture of the quadriceps expansion on the inner aspect of the patella and hemarthrosis of the joint, the knee is insecure thereafter, especially on extension against resistance, as in descending stairs, where the patella suddenly slips beyond the confines of the femoral intercondylar notch, the knee gives way, and the patient falls. (3) Structural causes are those wherein the angle of the pull of the quadriceps muscle on the ligamentum patellæ is increased as in knock-knee; infantile or spastic paralysis which causes elongation of the patellar tendon; or in general relaxation of the knee as in genu recurvatum. Goldthwaite originally pointed out that there is an angle formed at the junction of the quadriceps femoris and the patella with the apex inward which tends to become obliterated on contraction of the muscle and is only prohibited from doing so by the prominence of the external femoral condyle and by the strength of the quadriceps expansion mesially, and when these relationships are altered and resistance to this pull lessened the patella dislocates externally.

Of the twelve knees operated upon in this series, six could be considered as traumatic, four as structural and two congenital. Nine patients are represented.

The symptoms and findings of the congenital type are somewhat different from the others. Usually it is noticed shortly after the patient begins to walk that he falls often with collapse of one or both knees, usually both, for the condition is ordinarily bilateral. The patellæ are very rudimentary and upwardly displaced due to a congenital lengthening of the patellar tendon. The tibial tubercle is often laterally displaced, the ligamentum patellæ is entirely without the intercondylar notch, which structure is often not at all developed due to lack of required function, and the patella instead of lying flatwise in the coronal plane of the body is in the sagittal plane. As the patient grows older and heavier and play puts more demand on the functions of the quadriceps, falls become more frequent, so that the patient after awhile depends solely on outside support for locomotion.

In traumatic cases, as before indicated, there is no knock-knee, lack of development of the intercondylar notch or external femoral condyle, or elon-

* Read before the Philadelphia Academy of Surgery, May 2, 1932.

gation of the patellar tendon. Instead there is often palpable a longitudinal rent in the quadriceps expansion to the inner side of the patella. Especially is this true if on first examination there is an effusion in the joint, for in the presence of this the rent or defect is visible as a herniation, or palpable, there being a localized lack of the usual tense resistance felt in a hydrops of the knee. While at rest in extension the patella remains in the intercondylar notch but lateral pressure causes it to slide well out over the external condyle, and, if slowly done, active extension against resistance from a right angle with the part over the edge of a table will cause the patella to partially or completely dislocate externally, usually with some pain. In recent cases of this type there is sharp tenderness on digital pressure over the site of the tear. If treated conservatively in the beginning this defect will heal, but with the stress of use the scar stretches and symptoms come on later with collapse of the part, recurring dislocation and effusion.

In the structural cases, the physical findings are different from the other two types, even though the symptoms may be the same as in the traumatic cases. Knock-knees of varying amounts may be present, there may be atrophy or lack of development of the external femoral condyle. Genu recurvatum or lateral instability of the knee, either paralytic or rachitic, are found often in these cases. With the leg at rest in full extension the patella is partially externally dislocated, riding on the external condyle or even further displaced, and on resisted extension from a right angle the displacement increases without pain as a rule unless there has been a recent severe slipping accompanied by intraarticular damage. This type of case is practically always accompanied by marked arthritic signs with lipping of the joint edge, periarticular crepitation and limitation of motion both in flexion and extension and often a chronic synovitis with effusion. The gait of all patients with recurring external dislocation of the patella is a peculiarly guarded one especially in descending stairs, as in this function lies their greatest disability.

One dislocation of the patella favors another and many times these recurrences occur as often as once a week. With each attack the median patellar ligament, which extends from the patella to the iliotibial band, if not torn primarily, gradually stretches so that it no longer is of value in resisting the angular pull of the quadriceps. When this muscle is not under great tension frequent displacements occur without reaction in the knee, but where the resistance is greater and the tension of the muscle is great the local reactions are more severe and effusions are bound to occur. This probably is aided by the fact that the pain accompanying a partial external dislocation causes a sudden spasm of the hamstrings and immediate acute flexion of the knee with full dislocation of the patella, and with the knee flexed and the patella fully externally dislocated the quadriceps becomes a flexor and so the resultant trauma is decidedly increased.

The condition, when congenital, is apparent, but when acquired need usually be differentiated only from internal derangements of the knee caused

RECURRING EXTERNAL DISLOCATIONS OF PATELLA

by torn cartilages or loose bodies. The absence of local tenderness over the pathognomonic sore spots in cartilage injuries, the severity of the injury and the ease with which the lateral displacement of the patella can be accomplished with the knee in relaxed extension or in extension against resistance from the flexed position should make the diagnosis easy. The age of onset of this condition is usually in children or young adults, the oldest in this series being thirty-three and the youngest eight years. Females are said to be the more common sufferers and this series bears that out, seven females and two males. Knock-knee, while often a common predisposing factor, was present in but two of the structural cases, the congenital case and in one traumatic case. One traumatic case had definite bow legs.

Elongation of the patellar tendon was present in the congenital case and in one structural case, the boy having spastic hemiplegia from cerebral birth injury.

| Patient | Sex | Age at Onset | Age at Operation | Knock-knee | Elongation Tendon |
|-------------------|-----|--------------|------------------|------------|-------------------|
| <i>Congenital</i> | | | | | |
| E. M. | F. | Congenital | 11 | Moderate | Yes |
| <i>Traumatic</i> | | | | | |
| J. H. | F. | 30 | 37 | None | No |
| E. V. | F. | 33 | 33 | Slight | No |
| M. C. | F. | 19 | 23 | Bow legs | No |
| C. F. | F. | 29 | 30 | None | No |
| E. L. | M. | 13 | 14 | None | No |
| Bilateral | | 20 | 20 | | |
| <i>Structural</i> | | | | | |
| A. M. | F. | 11 | 51 | Severe | No |
| Bilateral | | 12 | | | |
| E. M. | M. | 18 | 19 | None | Yes |
| M. B. | F. | 8 | 9 | Moderate | No |

Relative to treatment, Steindler aptly puts it by saying that "conservative treatment is both inadequate and unsatisfactory." If it must be used, muscle exercises to develop the vastus internus, plus either a caliper brace or a knee cage to prevent rotation of the lower leg, might be theoretically of value. A wedge should be worn on the inner side of the shoe both to cause the patient to intoe and to relieve strain on the inner structures of the knee. In spite of these measures recurrences do occur.

Goldthwaite says that of all orthopaedic surgical conditions, operation for recurring external dislocation of the patella offers the greatest chance of success.

Many operations of various types have been devised for the surgical cure of this very disabling condition. All have the names of the originators attached but they can be divided into two main types, those on the soft parts alone, and those on the bones or bones and soft parts together. The latter are by far the more satisfactory.

Krogius has devised an operation based on the theory that the inner side of the quadriceps expansion is weak and stretched, thus permitting the patella to externally dislocate. He removes a strip of fascia from the inner side of the patella and inserts it in a longitudinal split in the fascia to the outer side and sews up both sides.

Gallie uses fascia lata in two strips sutured subperiosteally to the patella and fastened under tension to the inner femoral condyle.

Robertson and Whitlock use the tendons of the semitendonosis and gracilis respectively to hold the patella in place by inserting these tendons into the patella or quadriceps tendon.

Like all tendon or fascial transplants elsewhere the structures utilized tend to stretch after a while under the stress of function, and the condition recurs.

The transplantation of the entire tibial tubercle, with its attached patellar tendon, to the inner aspect of the tibia, has been done with success by some writers.

In cases of severe knock-knee a supracondylar osteotomy is necessary to correct the femoral deformity and when this is done the lower fragment with its attached lower leg has been rotated inward up to forty-five degrees to increase the prominence of the external condyle and thus keep the patella in its groove. This is objectionable because of the subsequent severe intoeing that ensues, which can be corrected only by the patient voluntarily walking constantly with the hips in a corresponding amount of external rotation.

Albee devised the operation of a linear osteotomy of the external condyle with the point of the osteotome directed anteriorly toward the patellar notch and the insertion of a tibial bone graft into the defect after prying the external condyle forward, thus permanently making this structure more prominent.

Goldthwaite ingeniously advises the longitudinal splitting of the patellar tendon from the patella to the tibial tubercle, the separation of the outer half and the lacing of this behind the inner half and its insertion subperiosteally on the inner aspect of the tibia. This technic was later modified, in that the portion of the tibial tubercle to which the tendon was attached was removed with the tendon and inserted as above. This procedure insures bony attachment for the outer half of the tendon in its new position.

| Patient | Date of Operation | Operations Done | Resulting Function |
|-------------------|-------------------|---|---|
| <i>Congenital</i> | | | |
| E. M. | May, 1924 | Bilateral osteotomy Goldthwaite-Gallie | Good |
| <i>Traumatic</i> | | | |
| J. H. | Aug., 1928 | Goldthwaite and Albee | Full |
| E. V. | Jan., 1930 | Goldthwaite and Albee | Full |
| M. C. | May, 1930 | Goldthwaite and Albee | Full |
| C. F. | June, 1930 | Goldthwaite and Albee | Full |
| E. L. | Feb., 1927 | Repaired rent and Albee | Full |
| | Feb., 1932 | Goldthwaite and Albee | Undetermined |
| <i>Structural</i> | | | |
| A. M. | June, 1927 | Bilateral Albee and Goldthwaite | Full |
| E. M. | Feb., 1931 | Goldthwaite and Albee | Full |
| M. B. | Oct., 1925 | Goldthwaite | Poor. Said to have had recurrence. Known to have had condition in opposite knee |

While this series is not large, certain deductions have been drawn as to the relative merits of these procedures. In the one case where the Goldthwaite operation alone was done in the presence of moderate knock-knees (M. B.), the result was poor and the patient is said to have had a reoperation.

In the congenital case where a supracondylar osteotomy, a Goldthwaite and a Gallie procedure were all done (E. M.), while there is good function, the patellæ have not remained anteriorly where they were post-operatively.

In the case where the rent in the torn capsule was repaired and plicated and an Albee operation done (E. L.), the patella can be easily manually dislocated laterally, even though function is full and there has been no collapse and falls in the intervening five years.

On the other hand, where the combined Albee and Goldthwaite procedures have been done, as is the case in the remaining eight knees, the patella on all motions of the knee remains in its groove and the function in each case is full. Therefore, this combined procedure is offered as giving the best hope for full function and relief of symptoms.

The incision which has been used is J-shaped with the long limb up the outer side of the leg and the lower limit of the curved limb extending below the tibial tubercle to the inner side of the knee. The Goldthwaite procedure is next carried out after mobilizing the patellar tendon on each side and the half to be transplanted with its attached tibial tubercle is drawn taut and inserted and attached under the periosteum as far mesially on the tibia as possible.

Next, the Albee procedure is undertaken with a broad osteotome and the external condyle pried forward. The bone graft to be inserted can be obtained from the tibia at the site of the transplanted tubercle, or, better still in our experience, from the side of the femur just behind the osteotomy cut, and it is then forcibly inserted into the prepared space.

The wound is closed in layers with interrupted sutures and a small rubber tissue drain is inserted at the osteotomy level, to be removed in forty-eight hours. A molded gypsum splint is applied to the whole length of the leg and the patient is kept in bed for two weeks.

When the sutures are removed a walking plaster bandage is applied from the groin to above the malleoli, kept from sliding down by adhesive strips attached to the leg, the lower ends turned up and incorporated in the plaster of Paris. The patient is permitted to walk in this for four or five weeks and then it is removed. No forcible motion is permitted and rarely is physiotherapy necessary, except, perhaps, massage to the quadriceps. Within six months from operation full motion returns to all and in some a much shorter interval is necessary.

There were no operative deaths or infections but the development of a hematoma at the osteotomy site proved annoying in a few early cases following which the rubber tissue drain was added to the technic.

In conclusion, from this small series one might stress a few apparent facts:

(1) Structural defects were present in but 50 per cent. of the twelve knees.

(2) No operations on soft tissue alone held the patella in its groove.

(3) The combined Goldthwaite and Albee operation has proven most satisfactory.

(4) Surgical treatment offers a safe and reliable cure for a most troublesome disability.

CASE REPORTS

Congenital.—E. M., female, aged eleven years. Noticed by parents that knees collapsed shortly after learning to walk. Patient's father, deceased, had the same complaint. As she got older she became unable to walk without help either by crutches or another person. On examination the patellæ were about one-third normal size and permanently displaced upward and to the outer side of the leg with the side of the patella in the sagittal plane of the body. There was moderate bilateral knock-knee. Operation May, 1924, two weeks separating the procedures on either leg, consisted of the Goldthwaite, supracondylar osteotomy and the Gallie fascial grafts. For five years she intreed very much but gradually actively overcame the deformity. No collapse of knees until 1931, when she married, became pregnant and gained much weight, when, unless she was careful, her knees would feel as though they would collapse and for the last two months of pregnancy she was kept off her feet to prevent this. After delivery she was rapidly brought back to normal weight and her knees now do not collapse. The patellæ have increased in size to about 60 per cent. normal. Her legs are straight, she has 20 degrees of extension right, and 25 degrees of extension left, actively against gravity measured from a right angle. She lives an active and comfortable life as a housewife, but the patellæ have gradually been drawn further laterally.

Traumatic.—J. H., female, aged thirty-seven years. Trouble began seven years before operation with a fall when she struck her knee against a curb. Following this the weakness progressed with frequent accompanying falls. Operation August 28, 1928. Goldthwaite and Albee combined procedures with the repair of a rent found in the inner side of the quadriceps expansion. There was no knock-knee. By January 18, 1929, had sixty degrees active and passive motion from full extension. She then tripped and fell and broke the opposite ankle, upon recovery from which the affected knee was fully restored to normal with the patella remaining in its groove.

E. V., female, aged thirty-three years. Slipped while walking about an elevated platform one week before admission. Slight knock-knee and marked effusion with the patella presenting on the lateral aspect of the knee. This had recurred twice within the week. Operation January 15, 1930, combined Albee and Goldthwaite procedures. June 20, 1930, had full, active extension and flexion to ninety degrees, gait normal, comfortable with the patella pointing forward and remaining in its groove.

M. C., female, aged twenty-three years. Four years before admission while playing tennis her knee gave way and patella became laterally dislocated, since which it had recurred often on use. There had been a chronic effusion for a year which was aggravated on injury. Definite bow legs. Operation May 4, 1930, combined Goldthwaite and Albee operations. There was full function on August 19, 1930, with the patella remaining in the groove and with the power of extension as strong as in the opposite leg.

C. F., female, aged thirty years. Three months before admission while playing on the floor with her children with her knees flexed, the affected knee gave way and the patella slipped laterally with marked subsequent effusion. Since then, whenever she flexed her knee the dislocation would recur, whether bearing weight actively or in flexing the knee passively. There was no knock-knee. Operation June 4, 1930, Albee and Goldthwaite combined procedures. December 1, 1930, there were no complaints, function was full and the patella could not be displaced from its notch.

E. L., male, aged fourteen years, right knee; aged twenty years, left knee. No knock-knee. In July, 1926, while standing erect, was deliberately pushed in the right popliteal space by another boy and his knee gave way. He was immediately unable to use the part and there followed a severe effusion. There were many recurrences before admission. Operation February 1, 1927. A longitudinal rent five centimetres long of the inner capsule was plicated, after excising a rolled-up edge 0.7 centimetre in diameter

RECURRING EXTERNAL DISLOCATIONS OF PATELLA

and three centimetres long which had become cartilaginous. The Albee operation alone was then done. There was full motion June 22, 1927. This knee has not collapsed, but the patient says it feels weak at times, and although on use the patella remains in its notch, when the part is relaxed in extension the patella can be easily displaced laterally without pain. While descending stairs in February, 1932, he was pushed by another person and his left knee gave way. He was again unable to walk. A severe hemarthrosis followed which was aspirated (200 cubic centimetres) and an elastic support applied, and on attempting to walk the knee gave way again accompanied by a second hemarthrosis, less severe. The patella was easily manually dislocated laterally. Operation February, 1932, combined Goldthwaite and Albee operation. Walking plaster bandage recently removed and patella cannot be manually displaced. Motion of thirty degrees from straight and no discomfort. End-result not fully determined.

Structural.—A. M., female, aged fifty-one years. Symptoms began at age of twelve years, one side by a fall and the other in attempt to kick a football. Severe knock-knees with five inches between the malleoli with the condyles together. In the intervening period each knee would give way without warning ten or twelve times a year, usually in descending stairs. Has worn elastic knee caps and braces without complete relief. Lately before admission was house fast because of fear of falls. On admission each patella was riding on or outside the external condyle. Against gravity from right-angle flexion only thirty degrees active extension was possible in either knee. Passively there was full extension on the left, and the right, which had more recently given way, lacked fifteen degrees of full passive extension. Passive flexion was possible only ninety degrees accompanied by severe intra-articular grating and all signs of localized traumatic arthritis with effusion. Operation right, June 13, 1927, and left, June 3, 1927, combined Albee and Goldthwaite operations. September 1, 1927, had full function with active motion each knee against gravity of ninety degrees to and from full extension. There has been no subsequent collapse or symptoms although the patellæ may be said to present themselves riding the external condyle although still in the groove. In June, 1928, the right internal semilunar cartilage was removed for internal derangement of her knee without disturbing the result from the previous operation.

E. M., male, aged nineteen years. Suffering from left spastic hemiplegia. One year before had fallen from some steps, injuring left knee. Knee clicked and grated on motion and patella was habitually externally dislocated. The patella was high and the tendon long. The legs were straight. Operation February 26, 1931, combined Goldthwaite and Albee operation. Full motion and function in July, 1931. The patella remained in the groove at all times but there was slight pain in the knee on descending stairs.

M. B., female, aged nine years. Fell April, 1925, while roller skating, since which left knee gives way often, especially when running or roller skating. Painful at first, not so lately. Knock-knee, two inches between malleoli with condyles together, and on extension of the lower leg against gravity or resistance patella dislocated laterally. Operation October 28, 1925, Goldthwaite only. In September, 1926, full motion knee and no symptoms referable to operated knee, but opposite patella, without injury, was becoming habitually dislocated. While never seen again it is reported that since then the patient's right knee has been operated upon and the left one re-operated upon because of a tendency to recurrence of external dislocation of the patella.

THE TREATMENT OF MAL-UNION FOLLOWING UNREDUCED POTTS' FRACTURE

BY LEWIS CLARK WAGNER, M.D.
OF NEW YORK, N. Y.

FROM THE THIRD SURGICAL DIVISION OF THE HOSPITAL FOR RUPTURED AND CRIPPLED

POTTS' fracture is a fracture of the lower end of the fibula with a serious injury to the lower tibial articulation, usually a chipping off of the internal malleolus or rupture of the internal lateral ligament, associated with a lateral dislocation of the foot and ankle. When this type of fracture is improperly reduced or treated, serious deformity and changes in the ankle-joint and considerable disability follow. This end-result picture is a rare occurrence but in clinics like these at the Hospital for Ruptured and Crippled, we see several cases a year and, of course, only in adults. The patients complain of incessant pain on walking and are dependent on apparatus or crutches to take the weight from the affected member. Arthritic changes of traumatic origin soon appear and the ankle is considerably swollen, tender and the motions are restricted or lost. Pain is often present at the knee-joint due to the valgus position of the ankle and the faulty weight-bearing surfaces, thus indirectly throwing the strain on the internal lateral ligaments of the knee.

Correct alignment of all joint fractures should always be eagerly sought for and one should have no hesitancy in proceeding with open reduction in all fractures about the joints, if proper position cannot be secured by closed methods. Even in the cases of joint fractures, when perfect alignment is secured (Figs. 1 and 2), there is a tendency in a certain number of cases for arthritic symptoms to appear from five to twenty years later.

The type of open operative treatment for cases of mal-union following unreduced Potts' fracture is one I have developed in our hospital with the idea of correcting the vertical and transverse alignment of the ankle-joint proper, which tends to throw the weight-bearing in its proper normal line. It has proven satisfactory as to appearance, relieving the pain and the return of motion to the ankle-joint.

Operative technic.—The leg is prepared in the usual manner and the operation is best performed with a tourniquet. The skin and subcutaneous tissues about the internal malleolus are divided and the lower end of the tibia exposed as shown in Fig. 7—A, A'. A similar incision is made over the external malleolus (B, B') but it is not necessary to expose the lower end of the fibula. The old fracture line in the deformed internal malleolus is removed with a chisel, taking out a wedge of bone (Fig. 9—E). A linear osteotomy of the lower end of the fibula is performed and the foot is placed in marked inversion, until the vertical and transverse alignment of the ankle-

MAL-UNION FOLLOWING POTTS' FRACTURE



FIG. 1.



FIG. 2.

FIG. 1.—Shows typical fresh Potts' fracture.

FIG. 2.—Shows fracture (Fig. 1) five years after reduction. There are beginning arthritic changes, which may occur in best anatomical replacement. The alignment is perfect.



FIG. 3.

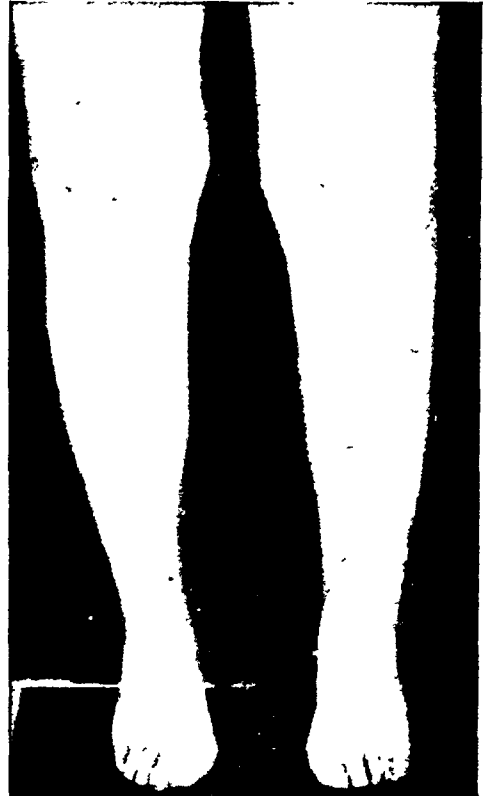


FIG. 4.

FIG. 3.—Photograph of legs, showing typical deformity of unreduced Potts' fracture (left) *i.e.*, swelling of ankle, valgus deformity and prominence of internal malleolus.

FIG. 4.—Same as Fig. 3 one year after operative correction of deformity. Legs are symmetrical.

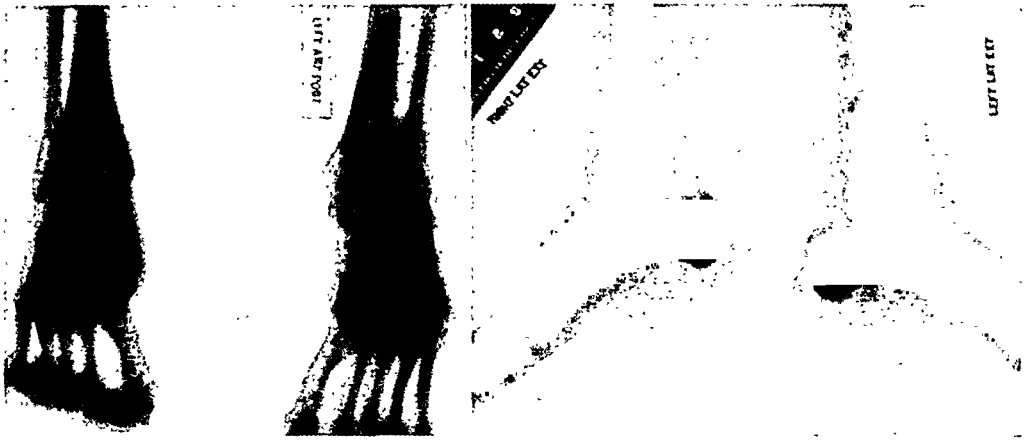


FIG. 5.

FIG. 6.

FIG. 5.—X-rays of normal ankle as compared to deformity of unreduced Potts' fracture. Note the alignment of weight-bearing, which is distorted on affected side. (X-ray is of case shown in Fig. 3.)

FIG. 6.—Lateral view of Fig. 5. Note distorted internal malleolus.

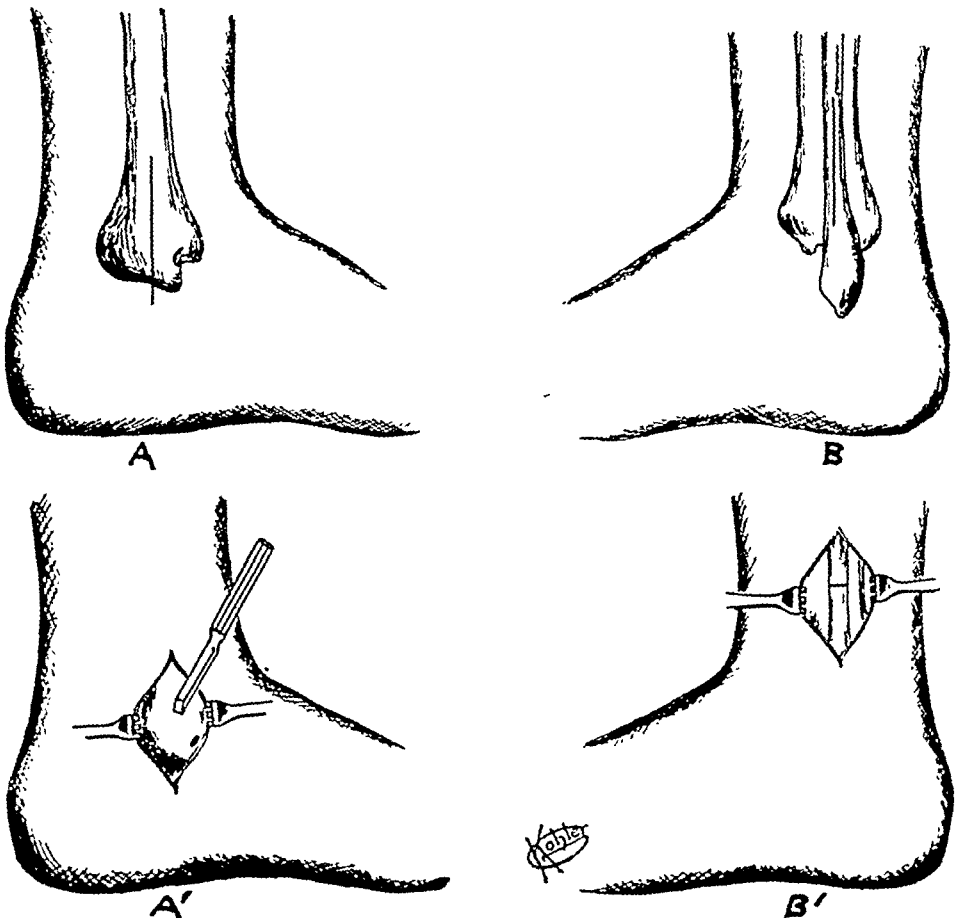


FIG. 7.—Shows the skin incision over internal (A and A') and external (B and B') malleoli needed for operative treatment of unreduced Potts' fracture.

MAL-UNION FOLLOWING POTTS' FRACTURE

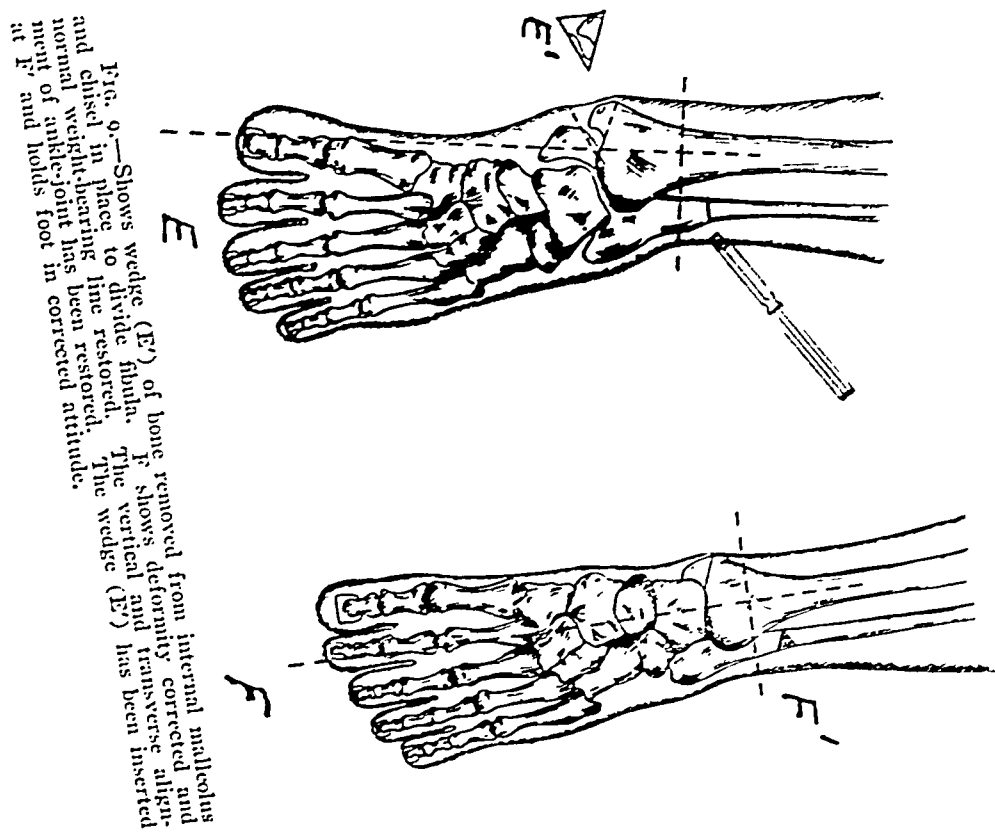
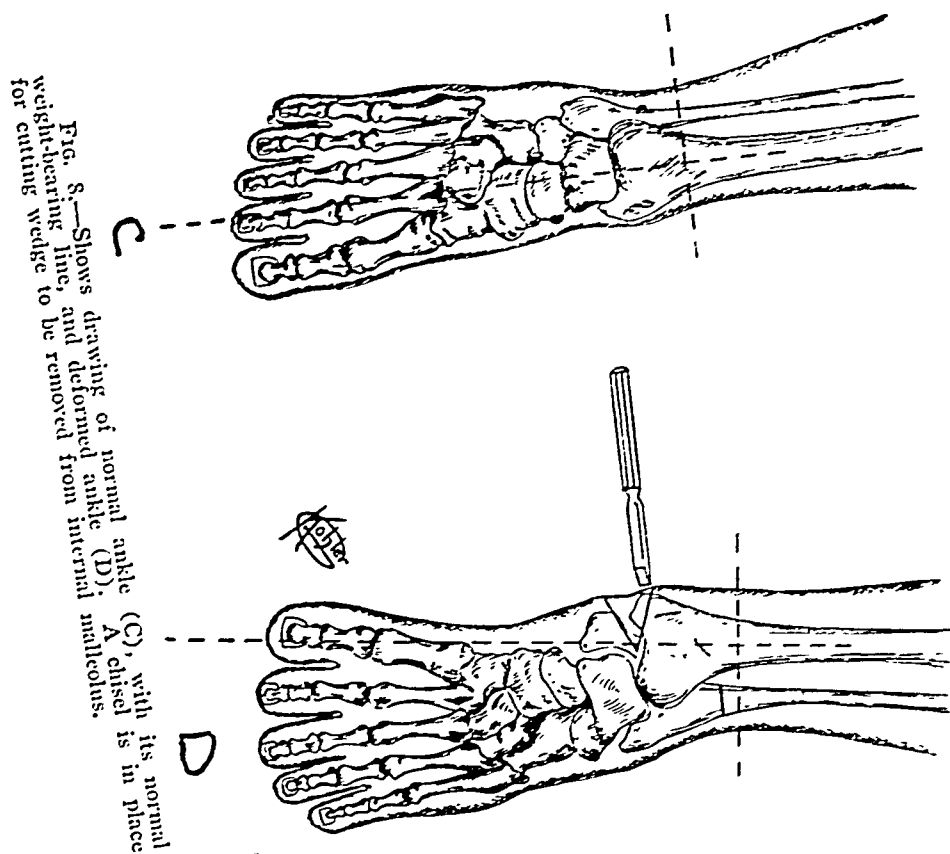




FIG. 10.

FIG. 11.

FIG. 12.

FIG. 10.—Shows post-operative result of Fig. 5. Foot placed in plaster in attitude of marked inversion.

FIG. 11.—Shows post-operative result one year after weight-bearing has been permitted.

FIG. 12.—Lateral view of Fig. 11.

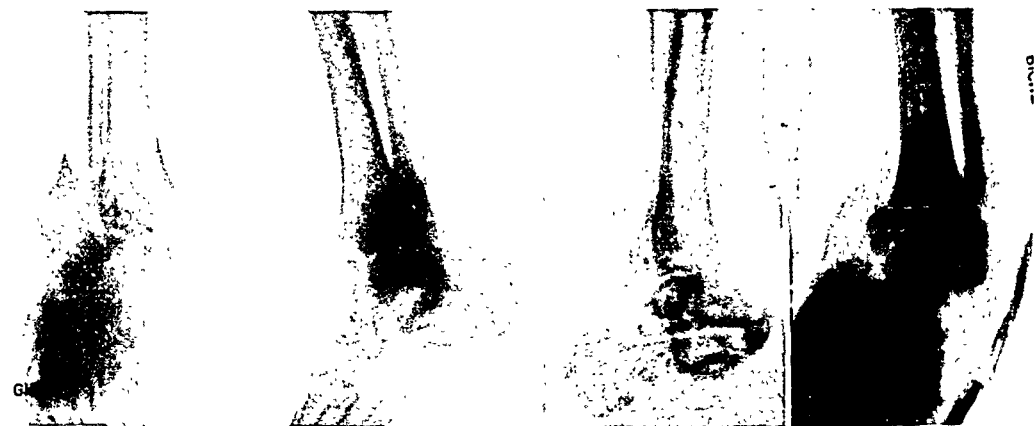


FIG. 13

FIG. 14.

FIG. 13.—Shows X-rays of case one year following fracture. (Extreme deformity.)

FIG. 14.—Shows X-rays of Fig. 13 after operative correction. Foot in marked inversion.

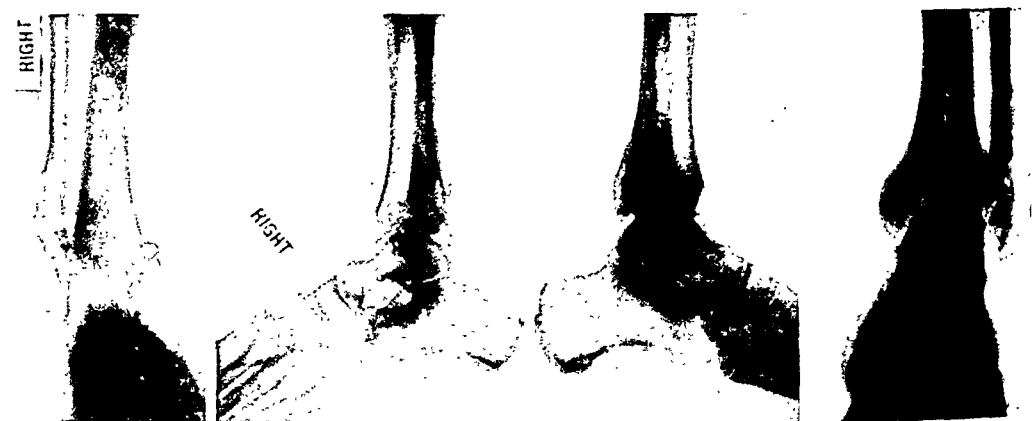


FIG. 15.

FIG. 16.

FIG. 16A.

FIG. 15.—Shows X-rays of Fig. 13 one year after operative correction.

FIG. 16.—Lateral view of Fig. 15.

FIG. 16A.—Shows X-rays of Fig. 13 two and one-half years after operative correction, with proper weight-bearing line still retained after continuous weight-bearing. No arthritic changes. Symptom free.

MAL-UNION FOLLOWING POTTS' FRACTURE

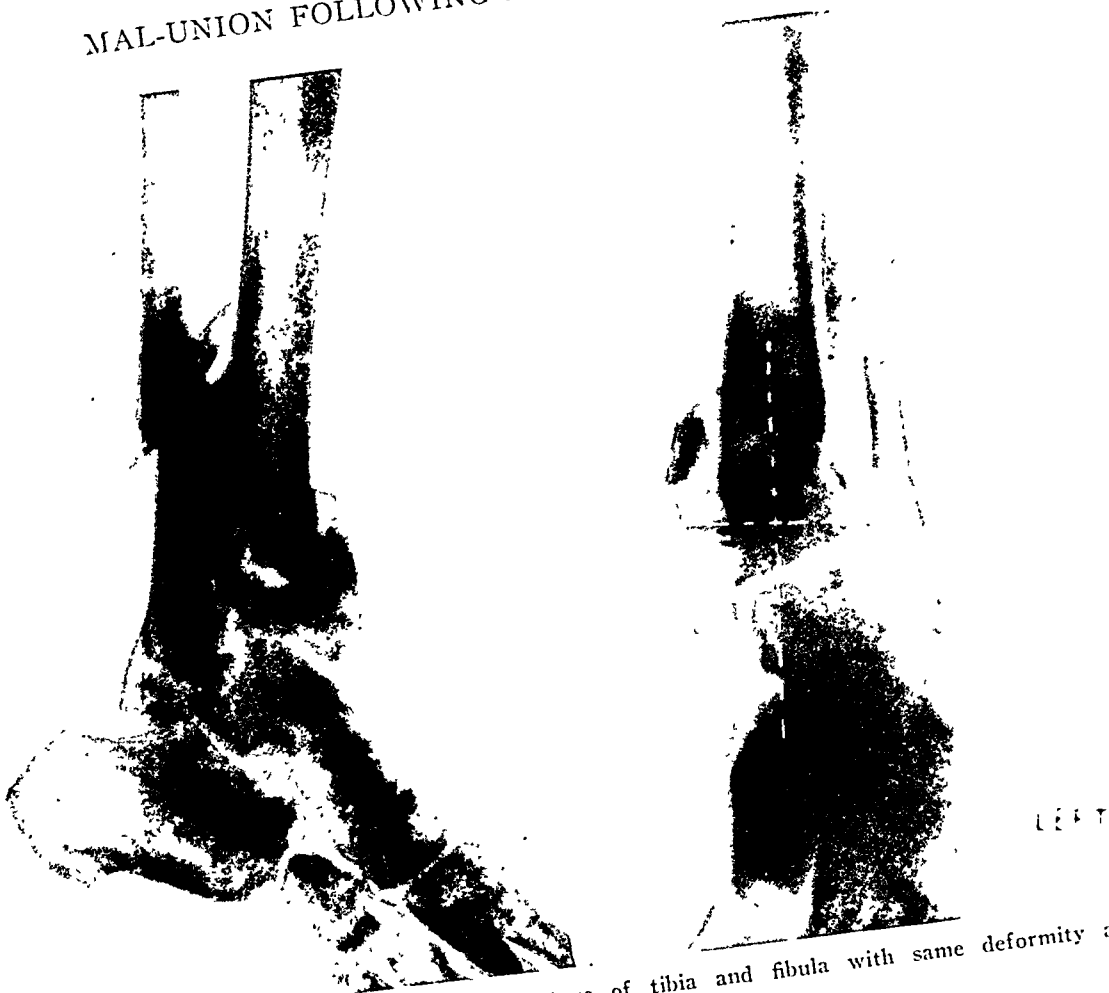


FIG. 17.—Shows X-rays of comminuted fracture of tibia and fibula with same deformity as Potts' fracture.

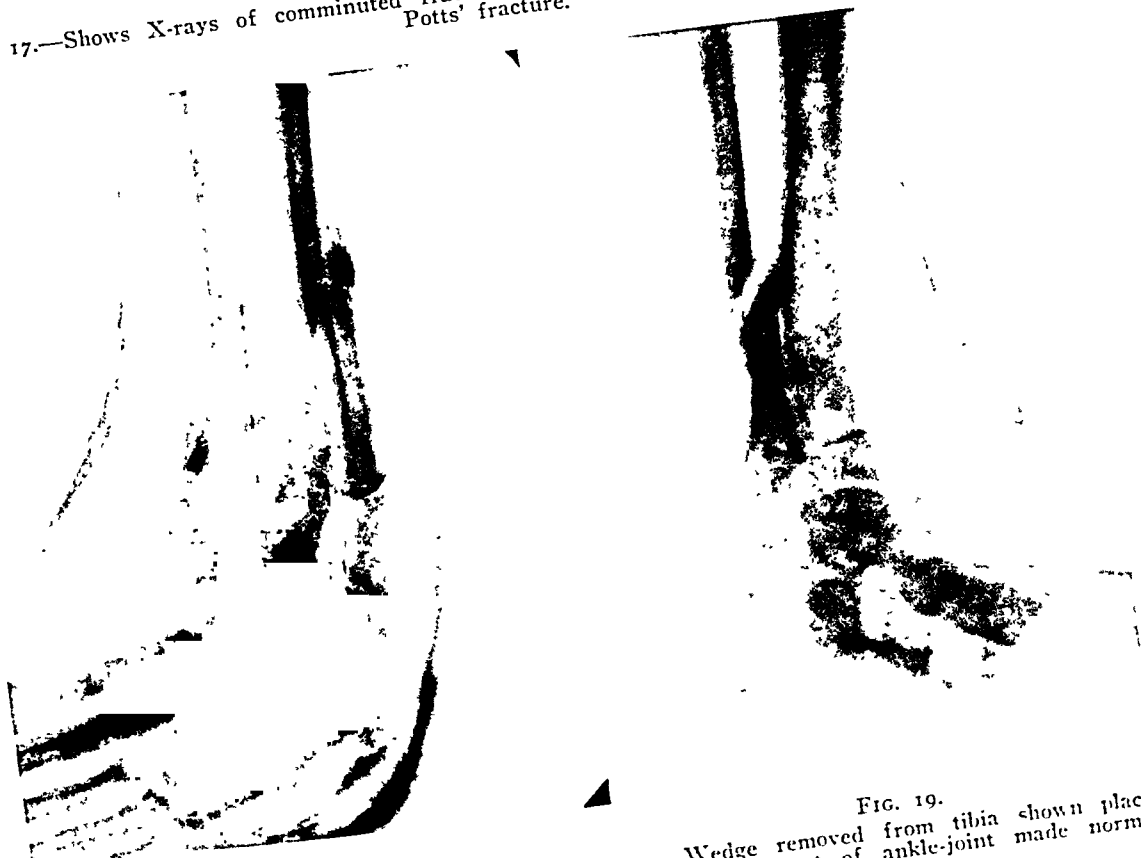


FIG. 18.

FIG. 18.—Shows operative correction of Fig. 17. Wedge removed from tibia shown placed between ends of divided fibula. Vertical and transverse alignment of ankle-joint made normal. Foot in marked inversion.

FIG. 19.—Lateral view of Fig. 17.

joint is secured as shown in Fig. 9—F. The wedge of bone (Fig. 9 E) is reshaped and placed between the separated ends of the fibula (Fig. 9 F) and should hold the foot in its newly assumed corrected attitude. A plaster dressing is applied with the foot in marked inversion. The plaster should extend from the toes to the knee.

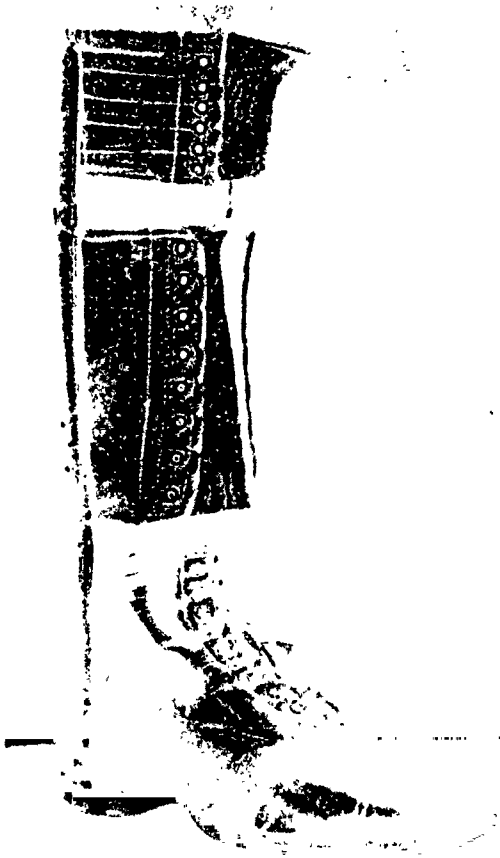


FIG. 20.—Caliper brace inserted in heel of high shoe.

After treatment.—At the end of six weeks from the date of operation a plaster is reapplied with the foot in slight inversion and the patient is encouraged to bear weight. Ten weeks from the operation a caliper brace (Fig. 20) to fit in the shoe and extend to the knee is applied. The function of the brace is to prevent a recurrence of the deformity by restricting any lateral motion and to allow flexion and extension of the ankle-joint. Walking is encouraged in the corrected attitude and physiotherapy is not particularly indicated. All support can be usually discarded about seven months after operation, when all signs of traumatic arthritis of the ankle-joint have disappeared.

SUMMARY.—Fourteen cases have been corrected by this method with pleasing results. The limp is the last symptom to disappear and usually in

the second year. I have had one complete failure because the brace was not used following the removal of plaster, which I now consider as important as the operative technic.

SUBCUTANEOUS ANGIOMAS OF THE BREAST

By JOHN G. MENVILLE, M.D.
AND JOSEPH COLT BLOODGOOD, M.D.
OF BALTIMORE, MD.

FROM THE PATHOLOGICAL LABORATORY OF THE DEPARTMENT OF SURGERY OF JOHNS HOPKINS HOSPITAL AND UNIVERSITY

OF APPROXIMATELY 3,000 breast cases collected in the Surgical Pathological Laboratory of the Johns Hopkins Hospital, the total group of angiomas includes eight benign and one malignant cases. Of the eight benign cases, seven proved to be hemangiomas and one lymphangioma. Only one of the seven hemangiomas was made up of the capillary variety; the six remaining cases belong to the cavernous type. The malignant angioma proved to be a malignant hemangio-endothelioma.

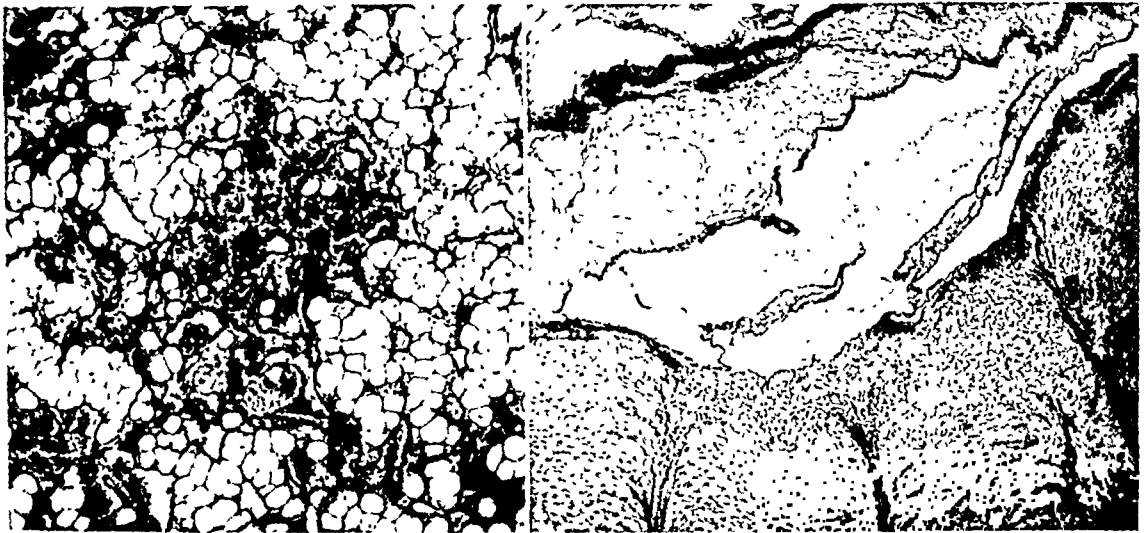


FIG. 1.

FIG. 2.

FIG. 1.—P. N., 36958, a white female, sixty-two years of age, who, five months previously, accidentally discovered a painless mass in her left breast, which had steadily increased in size. The left breast was slightly larger than the right. There was a suggested retraction of the nipple. In the upper, outer quadrant of the left breast there was a hard, irregular elastic mass, nine by five centimetres, which was attached to the overlying skin. Two pea-sized glands were felt in the left axilla. A diagnosis of sarcoma was made and a radical amputation of the left breast was performed. Two years later a symptomless mass appeared in the right breast together with tumefaction in the right axilla. *Operation.*—An excision of both masses was performed. *Result.*—The patient was well three years later. *Diagnosis.*—The breast tissue from both operations proved to be that of benign capillary hemangioma of the breast. *NOTE.*—The tissue photographed was taken from the second operation.

FIG. 2.—P. N., 16380, a colored male, six weeks of age, who presented a congenital, ovoid, colorless, cystic mass in his left breast. *Operation.*—The mass was excised. *Result.*—The result is not known. The microscopical picture reveals a section of a dilated and cystic lymph space. The contents, consisting of a fine, pink-staining mesh-work, is typical of coagulated lymph. The lining of the cavity is composed of partially desquamated and faintly visible, flattened, endothelial cells. The wall consists of fibrous tissue and is only faintly distinguished from the surrounding fibrous stroma. The stroma presents a slight round-cell infiltration. *Diagnosis.*—Lymphangioma (benign) of breast.

The term angioma implies a growth of newly formed blood- and lymph-vessels and includes the two classes: hemangioma and lymphangioma. For practical purposes both are subdivided into capillary (telangiectatic) and cavernous, although any gradation between these two extremes may occur. These lesions occur so infrequently in the breast that a more complete classification is insignificant.

Capillary (telangiectatic) hemangiomas are considered by Ribbert¹ to

arise from isolated segments of a vessel wall and to extend by a proliferation of new vessels. Ewing² believes that the logical explanation lies in a developmental anomaly found in vascular segments, which have retained their embryonal elements. Mallory³ believes that many of them are congenital and that the growth rate is rapid.

The cavernous hemangioma may be attributed to a weakening of the muscular and elastic coats lining the vessels. Rindfleisch and Borst⁴ stress the retraction of the fibrocellular growth in and around the vessel wall causing a shortening of the vessel and a dilatation of its lumen.

A certain percentage of the angiomas appear in the epidermis, but in the present study, they are classed as skin lesions and are not considered as angiomas of the breast. Subcutaneous lesions having no connection with the epidermis are the only tumors considered in this paper.

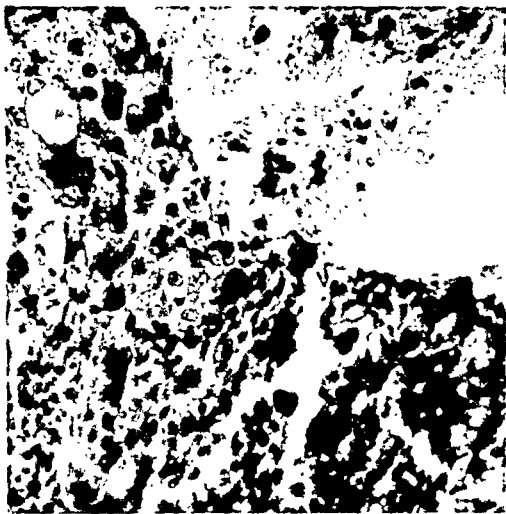


FIG. 3.—P. N., 18844, a female, fifty-three years of age, who complained of a slowly enlarging tumor in her breast. Examination revealed a cystic tumor in the lower-outer quadrant of her breast and a slight enlargement of the axillary glands on the left side. Operation.—A radical mastectomy was performed February 2, 1916. Result.—The patient died in 1926. The microphotograph represents a section of a cyst-wall and a small portion of the cyst lumen. The multiplicity and variation in the size of the hyperchromatic nuclei loosely situated in their cytoplasmic bed indicate a high type of malignancy. However, in spite of this malignant appearance, the patient lived ten years post-operatively. The nuclei are more characteristic of malignant endothelial cells than of any other type. A part of the cystic lumen is shown filled with red blood-cells and an occasional desquamated endothelial cell. Diagnosis.—Hemangio-endothelioma (malignant) of the breast.

From a clinical standpoint the recognition of angiomas has been difficult. This is particularly true in regards to the diagnosis of malignancy and benignancy. In the present series two (Path. No. 43645 and Path. No. 36958) of the seven benign hemangiomas were diagnosed clinically as being malignant. Path. No. 36958 (Fig. 1) represents a capillary hemangioma which grew slowly for one and a half years and from the presenting signs and symptoms was diagnosed as a sarcoma. The corresponding breast in this case was subjected to a radical amputation. Path. No. 43645 represents a cavernous hemangioma which was diagnosed clinically as a malignant growth and the breast amputated as a result. (See Figs. 1 and 2.)

The one lymphangioma (Path. No. 16380, Fig. 2) in the present series, occurred as a congenital growth in a colored male child. This mass was removed when the child was only six weeks of age.

The malignant hemangio-endothelioma is represented by Path. No. 18844 (Fig. 3.) This tumor was diagnosed clinically as a malignant growth but both the clinical and microscopical opinions varied from sarcoma to medullary carcinoma. However, the microscopical picture being more typical of malignant hemangio-endothelioma than any other type of breast pathology, the tumor was classed as a malignant angioma.

A correct estimate of the age incidence and duration of growth is impossible in this series. Although the majority of the tumors are found in middle-aged and old individuals the young and very young were almost equally represented.

A small number of cases and the incomplete data on them necessitate the incorporation of typical angiomas in general, in so far as they fit in with the cases studied, in order to furnish a complete and thorough description of angiomas of the breast. However, specific illustrations and outstanding points of the present series of breast angiomas will be stressed.

TABLE I

Subcutaneous Angiomas of the Breast

Path. No. 43745.—Female, aged thirty-one years. Operation.—July 30, 1928, excision of nodule. Result.—Lost. Microscopical Examination.—Cavernous cyst, endothelial lining, blood contents.

Path. No. 43645.—Colored female, aged twenty-one years; malignant tumor in right breast. Operation.—July 12, 1928, amputation of breast. Result.—Lost. Microscopical Examination.—Cavernous cyst, endothelial lining, blood contents.

Path. No. 40926.—Female, aged sixty-four years; benign adenoma tumor of right breast and right lower quadrant of twenty-four years' duration. Operation.—October 4, 1928, excision of tumor. Result.—Lost. Microscopical Examination.—Cavernous cysts, invaginated and endothelial lining, blood contents.

Path. No. 40312.—Female. Operation.—March, 1928, excision of tumor. Result.—November 12, 1929, well. Microscopical Examination.—Cavernous cyst, invaginated endothelial tissue and calcification.

Path. No. 38778.—Female. Microscopical Examination. Cavernous cyst, organization by fibrous (fibro-adenoma associated); blood contents.

Path. No. 36958.—White female, aged sixty-two years; malignant sarcoma of upper, outer quadrant of one and one-half years' duration. Symptoms.—Gradual growth tumor. Operation.—July 25, 1925, radical amputation of breast. Result.—Lost. Microscopical Examination.—Multiple capillary spaces, endothelial lining, blood contents.

Path. No. 36958.—White female, aged thirty-five years; gradual growth tumor of two years' duration. Operation.—July 24, 1922, excision of tumor. Result.—Lost. Microscopical Examination.—Cavernous cyst, endothelial lining, blood contents.

Path. No. 18844.*—Female, aged fifty-three years; malignant cyst (?) of lower outer quadrant. Symptoms.—Slow growth tumor; slight enlargement of axillary glands. Operation.—February 2, 1916, radical amputation of breast. Result.—Dead, 1926? Microscopical Examination.—Cavernous cysts, malignant endothelial lining, blood contents.

Path. No. 16380.†—Colored male, aged six weeks; benign cyst in left breast of six weeks' duration. Symptoms.—Congenital, ovoid, cystic tumor. Operation.—October 1, 1914, excision of tumor. Result.—Lost. Microscopical Examination.—Cavernous cyst, endothelial lining, coagulated lymph contents.

* Indicates a malignant-hemangio-endothelioma.

† Indicates a lymphangioma.

Hemangioma.—The simple, capillary (telangiectatic) hemangioma is represented by hypertrophy and hyperplasia of the endothelium of capillaries and veins which has probably arisen from the stimulation of an embryonic rest lying in the wall of a vessel. The cavernous type in all probability represents a regressive phase resulting from the loss of tone and structure of the vessel wall. The weakness of the vessel walls may be the result of

a congenital defect. The dilatation is characterized by a thinning of the vessel wall and a decrease in the intercellular stroma. Growth takes place by the budding of new vessels in the periphery of the lesions and usually begins as a simple or capillary form before merging into a cavernous variety.

Clinical Features.—Clinically, unless angiomas are sufficiently close to the skin to give a discoloration and an irregular, fluctuating, compressible mass, the diagnosis is difficult. There is no characteristic age distribution nor is there any sex limitation. In spite of the fact that the average age in the present series is 37.7 years, the tumors usually appear at an earlier age and progress very slowly. Cavernous angiomas are as a rule single but, as Esmarch⁵ has already shown, they may be multiple. The tumor may be circumscribed, and, in the regressive form, is encapsulated. Of angiomas in general it may be said that the association of these tumors with an afferent and efferent vessel may lead to a fluctuation in the size of the tumor. This phenomenon is sometimes noted during the periods of gestation and menstruation. In cases where angiomas anastomose with large arteries and veins it is possible for a rupture to produce fatal hæmorrhage. Hemangiomas may undergo regressive change together with ultimate fibrosis and calcification. Path. No. 40312. (Fig. 4.) This change may occur spontaneously or may follow irradiation treatment. The three most dreaded complications are rupture, infection, and malignant change.

The great majority of hemangiomas are benign, but in some cases malignancy does occur. For this reason one should always regard a hemangioma with suspicion until proved benign. A case of metastasizing cellular hemangioma of the breast has been reported by Borrmann⁶ in which the tumor recurred repeatedly after operation and finally proved fatal by metastasis to the lungs. Onsy,⁷ in a report of rare pathological tumors, demonstrated an angiosarcoma of the breast. Ewing² observed an angioma of the left breast with metastasis to the lungs. Schmidt⁸ reported on eleven cases of angiosarcoma in 1887.

The hemangio-endothelioma of the present series, Path. No. 18844 (Fig. 3), occurred in a fifty-three-year-old woman who presented a slowly growing cystic tumor accompanied by axillary gland enlargement. After a radical amputation of the breast the patient lived for approximately ten years. In spite of the enlarged glands no microscopical sections or any other clinical evidence of metastasis was found in the laboratory.

Gross Pathology.—The capillary (telangiectatic) variety exhibits a soft mass composed of small dilated capillaries and venules which, on section, are found to contain blood. The fibrous septa are prominent and offer a good stromal support for the vessels. The cavernous type presents a larger, more circumscribed growth composed of distended cyst-like structures which are interrelated and which are connected with an afferent and an efferent vessel. Section reveals a spongy mass composed of blood-filled sinuses separated by thin connective-tissue septa. A break in the lining or a weakening of the septa will produce very large dilatations.

SUBCUTANEOUS ANGIOMAS OF BREAST

Occasionally the presence of organization is found in the contents of the angiomas and if it has been present for a long time deposition of calcium salts may also be noted. (Fig. 4.)

The gross specimen of the malignant hemangioma, Path. No. 18844 (Fig. 3A and B) presented a bloody mass of necrotic tissue which was unidentified as any typical pathological growth.

Microscopical Pathology.—The presence of numerous small blood-vessels lined with endothelial nuclei and usually filled with blood is the typical



FIG. 4.



FIG. 5.

FIG. 4.—P. N., 20312, a female who complained of a mass in her breast. *Operation.*—The mass was excised. *Result.*—The patient was well one year and eight months later. The microscopical picture shows the end-result of an organized cavity in a case of cavernous hemangioma. Remains of the endothelial lining may be seen. The contents of the former cavity are represented by the proliferation of a collagenous fibrous tissue surrounding epithelial debris. Deposition of calcium salts may be seen within the collagenous fibres as well as within its fibrous wall. The surrounding stroma contains compressed cavernous spaces, which are partly undergoing organization, and an abundance of round-cell infiltration. *Diagnosis.*—Hemangioma, cavernous (benign), of the breast.

FIG. 5.—P. N., 40926, a female, sixty-four years of age, who complained of a symptomless "lump" in her right breast. Examination revealed a painless, lobulated, elastic, fluctuating mass, two and a half by three centimetres, which gave the impression of a group of cysts. However, the tumor was diagnosed clinically as an adenoma. *Operation.*—Under novocaine anesthesia the mass was excised. *Result.*—The result is not known. The microscopical picture shows multiple dilated cavernous spaces filled with blood and lined with flattened endothelial nuclei which are, in places, reduplicated. Several cavernous spaces show evidence of epithelial lined, invaginated, fibrous stalks which in one instance have almost bisected the cavity. The fibrous stroma shows evidence of a benign round-cell infiltration. *Diagnosis.*—Hemangioma, cavernous (benign), of the breast.

picture of capillary (telangiectatic) hemangioma. Path. No. 36958. (Fig. 1.) The lining is usually intact and the nuclei, which are seldom reduplicated, take on a dark chromatic appearance. The surrounding stroma, which is usually well developed, may or may not possess a lymphocytic infiltration. These tumors most frequently invade fat and fibrous tissue. When not connected with the general circulation the angiomas form concentric vascular whorls which frequently thrombose. The thrombi are followed by organization with fibrosis and calcification.

The cavernous type, Path. No. 40926 (Fig. 5) presents a varied appearance. The dilated blood spaces are lined with more elongated endothelial nuclei than those seen in the capillary form. These nuclei have a tendency to duplicate themselves. The lining is seldom regular. It is either broken through and leads to another blood space or the lining is invaginated by fibrous stalks which often bisect the blood caverns. The cavernous type is usually filled with blood. The stroma is sparse, being composed of loose, fibrous connective tissue with occasional nerves and blood-vessels. Near the periphery of the lesion there is sometimes found a budding of new vessels which simulate the capillary (telangiectatic) hemangiomas. They represent the growing portion of the tumor, and, unless regression takes place they will in time dilate into the cavernous form. Encapsulation of these vascular spaces is seen in the latter part of the disease when organization and retraction take place. Occlusion of the lumen, often produced by injury to the vessel wall, prevents the circulating blood from passing through the angiomatous beds and as a result these beds have a tendency to form a concentric mass. Invasion by fibroblasts with the deposition of collagen is frequently noted and when organization begins it usually continues to the ultimate stage of calcium deposition. Angiomas are occasionally complicated by infection and hæmorrhage, but rarely by malignant change.

The microscopical section of the malignant angioma in this series shows typical multi-layered, hyperchromatic, endothelial nuclei lining blood-filled cavities. The nuclei contain an abundance of mitotic figures. (Fig. 3B.) It may be argued that this tumor developed from a hæmorrhagic medullary carcinoma. Such a view is not supported by the multitude of medullary carcinomas in the laboratory.

Lymphangioma.—These tumors arise from lymph vessels and may be the result of a blockage of the afferent lymph vessels producing a stasis and a damming in the lacteals and lymph channels with ultimately the production of dilatation and tumefaction. However, they may also be the result of a congenital weakness in the vessel wall and may grow from the stimulation of embryonic rests. The only case collected in this series occurred as a congenital lesion in a Negro boy. (Fig. 2.) Clinically, these tumors present a picture similar to hemangiomas. Regardless of their proximity to the skin, the tumors are colorless. With the exception of complications, which are rare, the growths are symptomless and are noted only when tumefaction has proceeded to the point of detection. With few exceptions these growths are found subcutaneously and, in time, produce a tumefaction which is visible externally. Lymphangiomas of large dimensions have been described by Wegner⁹ and Pinner.¹⁰

Grossly, these tumors, which are comprised mainly of the cavernous type, present a grayish-white, translucent, lobulated, cystic mass, which, on section, often shows a spongy tissue containing grayish-white (lymph) fluid.

Microscopical Pathology.—The cavernous type of lymphangioma is seen in the great majority of cases. Rarely does one see the simple or capillary

(lacteal) form. The cavernous type, Path. No. 16380 (Fig. 2) is characterized by cystic dilatations filled, for the most part, with coagulated lymph and occasionally with the addition of red blood-corpuscles. The lining varies slightly from an oval to a flattened endothelial cell, which is sometimes reduplicated. The lining is very delicate and is occasionally invaginated into the lumen by a connective-tissue stalk. The stroma is composed of fibrous connective tissue which varies in density and which frequently contains a lymphocytic infiltration in its bed. This infiltration is greater than the corresponding type frequently found in hemangiomas.

The occurrence of both lymphangioma and hemangioma in a single tumor is not infrequently seen.

Discussion.—The angiomas of the breast present an interesting though infrequent group of breast tumor. They are at times difficult to diagnose clinically and when once diagnosed they may be even more difficult to treat. The lesions are usually found in middle-aged individuals as slowly growing, semi-fluctuating, subcutaneous tumors. Although the present series shows malignancy in 11 per cent. of the cases, many lesions are incorrectly diagnosed as such, Path. No. 43645 and Path. No. 36958, and unnecessary mutilating operations performed. However, since malignancy does occur this possibility should always be considered. Hemangiomas are particularly dangerous, not only in regards to malignant change, but also because of the constant possibility of fatal hæmorrhage.

A correct diagnosis of angiomas is essential, for the treatment depends on this clinical verdict. The presence of a circumscribed, irregular, spongy and cystic mass arising in the subcutaneous tissues of the breast, especially having a history of long duration, should always arouse the suspicion of angioma. However, an opinion should not be formulated until the procedure of a complete history, inspection and palpation has been carried out. The aid of transillumination (Cutler¹¹) as in all breast lesions should be used. However, its use has to be accepted with reservations, for no work has been done on the differentiation between angiomas and chronic cystic mastitis. The cases in the present study were seen before the work of Cutler was published.

Blue-domed cysts, especially when occurring as a part of so-called chronic cystic mastitis, may frequently be mistaken for angiomas.* When transilluminated the cysts are clear and should be less opaque than the blood-filled angiomas. The above statement is based upon the fact that in general, blood-

* Blue-domed cysts transilluminate clear. Hemangioma transilluminates dark. Lymphangioma clear. Neither as clear as the blue-domed cyst or as dark as the hemangioma. At exploration the blue-domed cyst is even a more definite gross pathological picture than the encapsulated adenoma. The blue dome is exposed as the operator uses the knife slowly and moves it from side to side as he proceeds beneath the subcutaneous fat, or after passing through breast tissue, or beneath the breast itself. When the cyst is nicked, the blue color disappears, the contents are clear or cloudy, never bloody; the wall is smooth.

filled cysts can be distinguished from clear-fluid cysts for in the former an opaque shadow is cast while in the latter the cyst transilluminates clear. The presence of large cystic masses casting a dark shadow on transillumination should be treated with suspicion, for such cases are difficult to diagnose clinically. Although the majority of malignant hemangiomas of the breast reported in the literature showed evidence of metastasis, the case in the present series (Fig. 3A and B) lived for ten years after operation with no available evidence of metastasis.

Because shadows are cast by the transillumination of hemangiomas, intracystic papilloma, and chronic cystic mastitis, the diagnosis in these conditions should be guided principally by the clinical picture. In contrast to the angiomas already described, chronic cystic mastitis usually presents a diffuse shotty breast. In some cases, and especially in the presence of papillomatous cysts, the picture is characterized by clearly outlined, definite, hard nodules which have a history of shorter duration and which occur deeper in the subcutaneous tissues of the breast. Another important clinical feature is the one popularized by Bloodgood,¹² *i.e.*, the history of a disappearing tumor in chronic cystic mastitis. Finney¹³ believes that the outstanding points of difference between angiomas of the breast and chronic cystic mastitis are the rarity of the spongy, cystic angiomas as compared to the frequent occurrence of chronic cystic mastitis with its firm and localized nodules.

Treatment.—The treatment of angiomas in the past has been extremely varied. The scientific advancements following in the wake of surgery have been slowly progressive and have to date culminated in a more satisfactory form of treatment.

In 1833, Macilwain¹⁴ reported successful results following the injection of pieces of thread. This was followed by the introduction of chemical substances and Giraldez,¹⁵ in 1854, working with perchloride of iron, was probably the first to report successful results. The chemicals used by the early authors include iodine, phenol and potassium iodide. Recently, interest in chemical therapy has been revived, to a certain extent, by the popularization of salicylates, sugars, quinine, and urethane, *etc.*, in the treatment of varicose veins. Heat and pressure were also popular methods of collapsing and sealing the walls of angiomatous areas. Wyeth,¹⁶ in 1902, introduced the method of injecting boiling water into the tumor areas. Because of the pain, discomfort and general poor results suffered from the above methods they have gradually fallen into disuse.

Good results have been reported with the use of electrolysis and carbon dioxide, but they are inferior to those produced by irradiation.

The susceptibility of angiomas to radium therapy and the good results obtained by its use have justified its recommendation as a most conservative though efficient form of therapy. MacKee¹⁷ advises soft beta rays in all lesions which are not deeper than two to three centimetres, but prefers radium to X-ray in the treatment of cavernous angiomas. In his treatment

he advocates flat applicators screened with 1/10 to 1 millimetre of aluminum with a dose just a little less than the amount required for a first-degree reaction. The treatment may be repeated every three or four weeks depending on the size and depth of the lesion. Although MacKee prefers beta rays in treating lymphangiomas, he has not obtained very good results in the treatment of these tumors. Among the recent reports of radium therapy on angiomas are those of Coliez¹⁸ and Simpson.¹⁹

The small, localized angioma may be safely excised but the possibility of cutting down on a vascular, infiltrating tumor is always present. On the other hand, the larger and more diffuse lesion, which is usually a cavernous hemangioma, should never, by choice, be excised, for this tumor is usually very vascular and, because of its growth, perfect hemostasis is, at times, impossible. Although Light²⁰ has reported successful treatment of a cavernous hemangioma by the injection method and that injections should be used only in certain types, the author believes that the effects of radium therapy justify its recommendation. However, if excision is insisted upon, irradiation should be used pre-operatively, for the shrinkage it produces lessens the possibility of hæmorrhage.

In cases where the diagnosis of angioma is strongly suspected, irradiation should be used, but with the knowledge that poor or slow results should be followed by more radical treatment. In such conditions exploration with biopsy and frozen section diagnosis should always be resorted to.

CONCLUSIONS

(1) Angiomas of the breast are rare. A total of nine cases were found in a collection of approximately 3,000 breast tumors.

(2) There are two types of angiomas in the breast, namely: hemangioma and lymphangioma. The angiomas are subdivided into the capillary and cavernous types.

(3) The exact etiology is unknown.

(4) There is no characteristic age incidence.

(5) The lesions may be congenital. Their symptoms are usually of long duration.

(6) Angiomas may occur in the male as well as the female breast.

(7) Malignancy occurs in 11 per cent. of the cases and is of the hemangio-endothelial variety. The one case in the present study showed no metastasis and lived ten years post-operatively.

(8) A correct diagnosis is essential.

(9) Irradiation with certain reservations should be the first treatment instituted.

SUPPLEMENTARY NOTES BY DOCTOR JOSEPH C. BLOODGOOD

Doctor Menville has asked me to write a note on this study of a rare type of benign breast tumor. Doctor Menville is the first to collect the hem- and lymph-angiomas of the breast among the cases recorded in the laboratory and presents for the first time in American literature a thorough and comprehensive study of the actual

relative positions of these angiomas among a large group of breast cases which have been collected in one surgical clinic since 1892.

The importance of such studies of benign conditions of the breast is greater today than ever before. In the days when Velpeau wrote his book on the breast (1840), the diagnosis could be made clinically and confirmed by the gross pathology and the result, which in Velpeau's time was always fatal in malignant tumors. Now and then, as recorded by Billroth of Vienna, a so-called serocystic sarcoma of Brodie would live for many years after the complete removal of the breast and tumor. Very few students of breast lesions realize that Velpeau wrote his book before the microscope and in his introduction to the second and third editions calls attention to the errors of the microscope in diagnosing malignancy of breast lesions. We now know that it was not the fault of the microscope, but the early microscopic pathologists could not compete with Velpeau's clinical and gross pathological experience. William H. Welch, in a conversation with me some years ago, found the same to be a fact when he travelled through our great Western cities. The surgeons were very much like Velpeau, men of large clinical and gross pathological experience. Their pathologists were still young and inexperienced, and when Welch was called upon to settle differences of opinion, he usually found the microscopic pathologist in error.

When Halsted came to Johns Hopkins in 1889 he ranked highest among the gross pathologists in the world. The records of the Surgical Pathological Laboratory of his department of surgery prove this. On but a very few occasions did Halsted diagnose benignancy in a breast lesion from the naked eye appearance which later, on microscopic appearance proved to be malignant, and this diagnosis of malignancy was confirmed by the subsequent death of the patient from cancer. I remember distinctly the first case. It was a smooth-walled cyst containing blood; cancer could not be seen in the wall of the cyst; yet, later, the microscope showed it. Halsted first removed the cyst only; after the microscopic study he performed the complete operation; the highest axillary glands were involved. The patient died of cancer.

We learned for the first time then that smooth-walled cysts filled with blood are malignant. Nevertheless it would be wise always to make a frozen section of the wall. I could imagine an organized hematoma to appear as a smooth-walled blood cyst, and some of the cases reported by Doctor Menville are described as cysts containing blood. For this reason a benign hemangioma may have the gross pathology of a blood cyst. It has been my misfortune not to have seen one so far. If the cyst contains a papilloma, the hemorrhagic contents is no longer diagnostic of malignancy. I have recently, in the *American Journal of Cancer* (vol. xvi, pp. 103-176, January 1932), and ten years ago in the *Archives of Surgery* (November, 1921, vol. iii, pp. 445-542; Reprint 99) reported on border-line breast tumors which have accumulated, from all sources, in the laboratory during all these years. Most of the early cases were explored by Doctor Halsted himself. He examined them most critically with the naked eye and removed locally. They were all examples of non-encapsulated adenoma, or zones of chronic cystic mastitis. Ultimately they were diagnosed microscopically as adenocarcinoma, malignant adenoma, or suspicious of malignancy, and usually within a few days or two weeks the complete operation for cancer was performed. A larger number of cases of this type were received from outside sources. Practically all of these patients have been followed for five or more years after operation. Many are living today. In not a single instance did signs of malignancy develop before death, usually of other causes, or among those living today. Doctor Halsted's acuteness in the recognition of malignant breast tumors by the naked-eye appearance is most dramatically shown in these observations. It is important to remember that during Doctor Halsted's activities up to 1915 the great majority of breast tumors were malignant and, with few exceptions, recognized as such clinically, all of them very distinctly in the gross.

SUBCUTANEOUS ANGIOMAS OF BREAST

Since 1915 we have required a frozen section with increasing frequency to differentiate the benign from the malignant.

This is due to the fact that perhaps the most common pathological condition occurring in the female breast is chronic cystic mastitis. This bilateral disease of the breast may be present without any clinical evidence. The clinical evidence—pain, tenderness, discharge from one or both nipples, single or multiple lumps in one or both breasts—may be present a month or two and then disappear forever or to return in a certain per cent. of the cases. For this reason the longer a woman waits after observing anything unusual in one or both breasts, the less the likelihood of finding chronic cystic mastitis. In the first ten years of Halsted's clinic, up to 1900, 80 per cent. of the women who entered the clinic because of some trouble in the breast were found to have cancer, and among the 20 per cent. with benign lesions only a small number belonged to the type of chronic cystic mastitis.

In that decade, which ended thirty years ago, in less than 1 per cent. of the women whose records we still have were not operated on, because clinically the condition was benign and the surgeon for some reason postponed operation during which time the palpable tumor disappeared.

Coincident with the education of women in regard to the danger of delay when anything unusual is observed in one or both breasts, there has been a tremendous change in the relative frequency of benign and of malignant tumors of the type of the benign tumor, and a great increase in the number of benign conditions for which, surgeons are learning, operation is not indicated nor necessary. The largest number of cases in this latter group are chronic cystic mastitis.

We need more studies similar to this one of Doctor Menville's of the rarer benign lesions of the breast and especially of their microscopic appearances. It is essential that there should be a follow-up, and the most valuable cases are those in which more than five years have passed since the operation and the result is known irrespective of the extent of the operation. In the list of cases reported by Doctor Menville the unfortunate thing is that in the majority of cases the patient has been lost track of. It is to be noted, however, that in the Surgical Pathological Laboratory of the Johns Hopkins Hospital a large number of these rare tumors, on account of their rarity, and the difficulty of an accurate diagnosis, are received from outside sources and for this reason are more difficult to follow for many years. There is, however, a distinct hem- and lymph-angioma of the breast. It may or may not give the compressibility of a hemangioma; it may or may not have the distinct gross appearance of an angioma; it may or may not appear as a blood cyst. Therefore it must be recognized at the exploratory incision by the aid of a microscopic section. Malignant hemangio-endothelioma, or the malignant lymph- or hemangioma have a microscopic appearance very difficult to differentiate from the benign. We have just had such an observation in which the tumor first appeared on the forearm. The certainty that the lesion was malignant was not established until there was local recurrence which temporarily disappeared under irradiation and then recurred again after a second local removal followed by amputation and then death from metastasis.

Doctor Menville has placed before us everything it was possible for him to get from the records and the pathological study of the material. The failure of the follow-up was not his fault.

I am writing this discussion, because I wish to present at every opportunity the necessity for clinicians, operators and pathologists to familiarize themselves with chronic cystic mastitis. To repeat, it is the most common condition of the breast among women who are examined in a few weeks after the first symptoms, among women whose breasts are examined in the routine physical survey and who have observed nothing unusual about the breasts. My personal studies and those of my associates in the laboratory lead to the conclusion that chronic cystic mastitis is not a lesion that precedes cancer. The presence of this bilateral lesion of the breast, whether found

clinically or at the operation, does not justify the removal of the breast. In a large per cent. of the cases it can be recognized clinically, in all it should be discovered at the exploratory incision. The microscopic appearance of chronic cystic mastitis is more puzzling to the pathologist than the clinical signs.

This disease known most commonly under the term chronic cystic mastitis is observed in women during the cancer age—after twenty-five years. It may appear clinically as a single lump, or as a lump in each breast, or multiple lumps in one or both breasts. The lumpy breast in which as a rule the lumps are indistinct is with the rarest exceptions bilateral. This is true also of the shotty breast known as the breast of the Schimmelbusch or Réclus type. Then there is a clinical and pathological type which I have described as more common in women at the menopause or shortly after lactation. One feels beneath both nipples one or more masses which feel like a single worm or a bunch of worms. I have described this as the varicocele tumor of the breast. The most common clinical type of chronic cystic mastitis is a single tumor which when explored proves to be a blue-domed cyst, when opened has clear or cloudy fluid. Dr. Robert Abbe of St. Luke's Hospital in New York, aspirated these cysts before 1900. Today I have returned to this method. The most helpful diagnostic sign is found on transillumination of the breast as first practiced and advocated by Dr. Max Cutler. If the palpable tumor is larger than a twenty-five cent piece and transilluminates clear, whether it is single or multiple, operation is not necessary. If the tumor does not disappear or becomes larger, or annoys the patient by fear or pain, aspirate it. If the fluid is clear or cloudy, do not operate. It is important to note that when the fluid is any other than clear or cloudy, the transillumination will be dark. When a single tumor, smaller than a twenty-five cent piece transilluminates clear we have not yet had sufficient experience to postpone exploration, but we have learned that when a doubtful tumor is explored and a blue-domed cyst is exposed, it is no longer necessary to excise that cyst with a zone of breast. All one needs to do is to open the cyst, let out the fluid, inspect and palpate the surface of the cyst and take a small piece of the wall and the surrounding breast for frozen section. The advantages of this minor operation over complete excision of the cyst with a zone of breast tissue, are that the wound in the breast is insignificant, no plastic closure of the breast is necessary, and the patient may, with the least risk, leave the hospital the same day.

I propose to ask Doctor Menville to make a second report on lymph- and heman-gioma of the breast in which he will take up the differential clinical diagnosis and, if possible, ascertain the results in some of the cases recorded as lost.

That this angioma of the breast is rare is exhibited by the fact that I have never explored one. The operators in the nine cases recorded here were either some other surgeon associated with the Johns Hopkins Surgical Clinic or the specimen was received from outside sources.

JOSEPH COLT BLOODGOOD.

BIBLIOGRAPHY

- ¹ Ribbert: Virchow's Archiv., vol. cli, p. 381, 1898.
- ² Ewing, James: Neoplastic Diseases, Third Edition. W. B. Saunders and Company, pp. 243 and 245, 1928.
- ³ Mallory, Frank B.: The Principles of Pathologic Histology. W. B. Saunders and Company, p. 310, 1929.
- ⁴ Rindfleisch, and Borst: Quoted by Ewing. Neoplastic Diseases, Third Edition. W. B. Saunders and Company, p. 247, 1928.
- ⁵ Esmarch: Virchow's Archiv., vol. xxxiv, p. 6, 1854.
- ⁶ Borrmann: Ziegler's Beitrage z. path. anat., vol. cccclxxii, p. 40, 1907.
- ⁷ Onsy, Anis: Angio-sarcoma of the Breast. Jour. Egyptian Med. Assn., vol. xiv, pp. 418-419, August, 1931.

SUBCUTANEOUS ANGIOMAS OF BREAST

- ⁸ Schmidt: *Archiv. fur Klin. Chirurgie*, vol. xxxvi, p. 421, 1887.
- ⁹ Wegner: *Lagenbeck's Archiv. f. Chirurgie.*, vol. dcxli, p. 20, 1877.
- ¹⁰ Pinner: *Centr. f. Chirurgie.*, 1880.
- ¹¹ Cutler, Max: Transillumination of the Breast. *ANNALS OF SURGERY*, vol. xciii, p. 223, 1931.
- ¹² Bloodgood, J. C.: Personal Communication. Baltimore, Md.
- ¹³ Finney, J. M. T.: Personal Communication. Baltimore, Md.
- ¹⁴ Macilwain: *Med. Chir. Trans.*, vol. xviii, p. 189, London, 1833.
- ¹⁵ Giraldes: *Bull. Soc. de Chir. de Paris*, vol. iv, p. 361, 1854-1854.
- ¹⁶ Wyeth: *New York Med. Jour.*, vol. lxxvi, p. 969, 1902.
- ¹⁷ MacKee, George M.: X-rays and Radium Treatment. Lea and Febiger, p. 488, 1921.
- ¹⁸ Coliez, R.: Radium Therapy of Angiomas in Children. *Prat. Med. franc.*, vol. xi, pp. 419-429, September (A-B), 1930.
- ¹⁹ Simpson, F. E.: Radium in the Treatment of Hemangioma of the Larynx. *Jour. Am. Med. Assn.*, vol. xcvi, pp. 342-344, January 31, 1931.
- ²⁰ Light, S. E.: Injection Treatment of Cavernous Hemangiomas. *Arch. Dermat and Syph.*, vol. xxiv, pp. 992-998, December, 1931.

THE EFFECT OF BLOOD IN EXPERIMENTAL PERITONITIS*

BY LEE RADEMAKER, M.D.

OF PHILADELPHIA, PA.

FROM THE DEPARTMENT OF SURGERY, SERVICE B, AND THE LABORATORY OF SURGICAL RESEARCH,
OF THE UNIVERSITY OF PENNSYLVANIA

DUFF ALLEN,¹ in 1927, showed that the presence of blood in the pleural cavity was an important factor in the production of experimental empyæma. The addition of one to two cubic centimetres of autogenous blood to broth cultures of pneumococci and streptococci injected into the pleural cavity of dogs gave a much higher incidence of empyæma in these animals than in those receiving similar cultures without blood. From his experiments, Allen concluded that blood increased the incidence of empyæma and believed that under such conditions an increase in virulence of bacteria might be the result.

The peritoneum of animals is well known to be resistant to infection, especially by artificial means. In attempting to evaluate various means of treatment in the experimental animal, the problem of developing a satisfactory peritonitis became one of primary importance. The introduction of organisms into the peritoneal cavity of rabbits and guinea-pigs has failed to produce peritonitis consistently.

The belief that blood may have a deleterious effect by reason of its being a good culture media existed many years before Allen's publication. Thus Schumann,² in 1921, in his monograph on ectopic pregnancy, discusses this feature of blood in the peritoneal cavity. The usual result of blood in the peritoneal cavity in ruptured ectopic pregnancy when the hæmorrhage is not so rapid as to cause death or immediate surgical attention, seems to be the formation of an hematocele.

This Schumann explains on the basis that blood acts as a foreign body, setting up peritoneal irritation and aseptic peritonitis, with exudate and the formation of adhesions. He further states that the real gravity of hematocele lies in its susceptibility to infection. "Given a mass of blood mixed with fibrinous exudate and in intimate contact with the intestinal walls, infection by the ubiquitous colon bacillus is a natural sequence and the conversion of this clot to a pulvic abscess is naturally a common occurrence." He states, moreover, that in most cases the infection is of such low grade that the tissues do not break down, but perimetritis occurs.

The possible analogy of peritoneum to pleura as regards its reaction to blood was further explored by Sparks and David,³ in 1929. Basing their experiments upon those of Allen, they injected various amounts of autogenous blood and various amounts of broth culture of staphylococci, streptococci, and colon bacilli into the peritoneal cavity of dogs, rabbits and guinea-pigs. Peritonitis was produced only by the streptococci in rabbits and in the control animals the incidence of peritonitis was the same as in those receiving blood. Dogs and guinea-pigs were resistant in all cases. In the experiments of Sparks and David the dogs received twenty to 100 cubic centimetres of blood and ten cubic centimetres of broth culture, the rabbits three cubic centimetres of blood and three cubic centimetres of culture, and the guinea-pigs one cubic centimetre of blood and one centimetre of culture. The authors concluded that autogenous blood together with varying types of pathogenic organisms injected into the peritoneal cavity of dogs, rabbits and guinea-pigs does not predispose to the production of peritonitis.

Hermann⁴ also attempted to use blood to aid in the production of peritonitis in rabbits. He found that attempts at modifying the virulence of the fecal flora by incu-

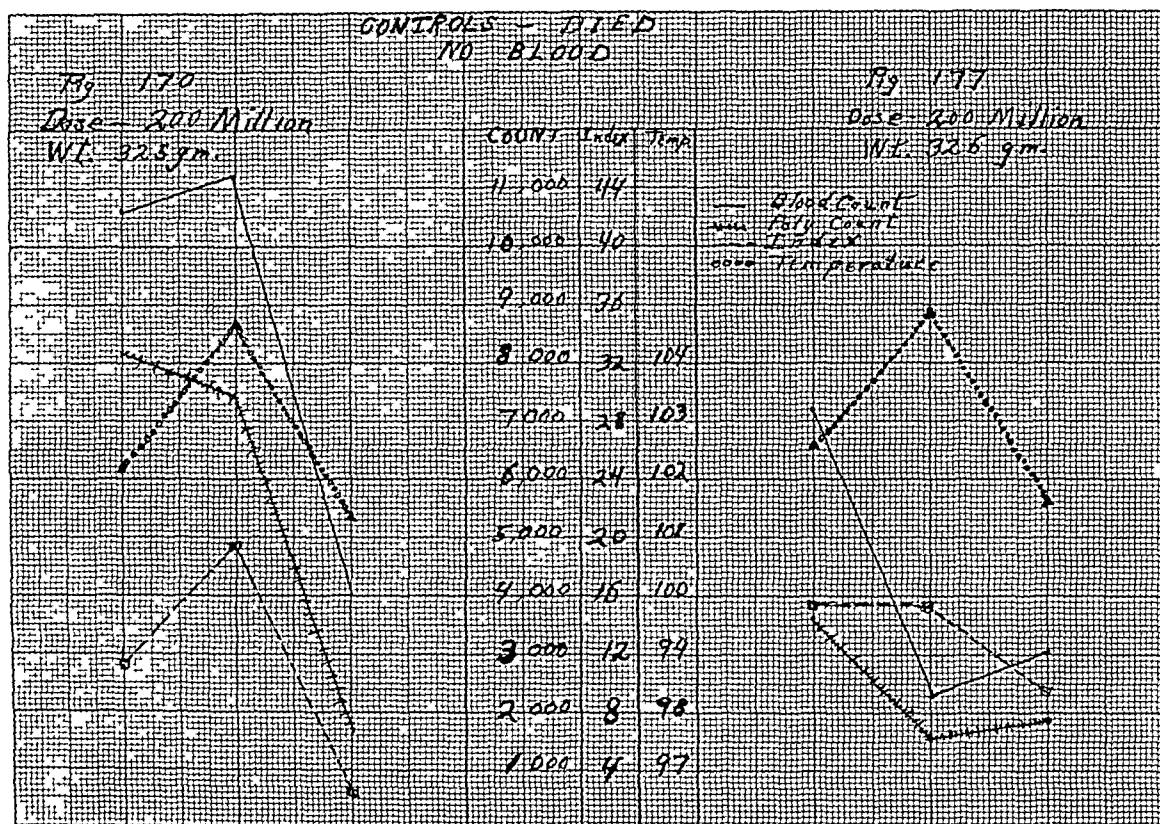
* Read before the Philadelphia Academy of Surgery, May 2, 1932.

EFFECT OF BLOOD IN EXPERIMENTAL PERITONITIS

bation with rabbit's blood or by the simultaneous injection of blood with organisms were unsatisfactory. He stated that the rabbits died more consistently when blood was added, but necropsy did not show peritonitis. No protocols were published of his experiments on the effect of the addition of blood.

From the data in the literature it is difficult to evaluate the effects of blood in the peritoneal cavity on the production of experimental peritonitis. It has never been shown that the presence of blood in the peritoneal cavity has any effect upon the production of peritonitis.

The effect of blood in the peritoneal cavity without infection has been studied by Sabin and absorption rates have been studied by Florey and Witts.⁴ Sabin has shown that the presence of blood in the peritoneum sets up a mild peritoneal reaction into which macrophages soon enter to take up and phagocytize the red blood-cells. The contri-



bution of Florey and Witts is of value in that they demonstrate the slowness of complete absorption of blood from the peritoneal cavity. Thus even relatively small amounts of blood are not completely absorbed for at least forty-eight hours. They, too, cite the danger of infection, mentioning the death of several animals from septicæmia after septic punctures of the abdominal wall. They demonstrated blood to be absorbed via the thoracic duct at a steady slow rate. They believed that the rate of absorption of red cells was influenced by the intra-abdominal pressure and by the depth of respiration. Sweet and Smythe,²⁰ in 1921, demonstrated similar facts concerning the absorption of blood from the peritoneal cavity.

Many foreign substances have been studied in relation to the production or treatment of peritonitis. Steinberg and Goldblatt²⁵ have demonstrated that any mechanism which decreases absorption from the peritoneal cavity in the presence of infection within that cavity favors the development of a peritonitis. Any mechanism which permits of normal or increased absorption is associated with recovery of the animal and failure to produce a typical peritonitis. Absorption was determined in terms of the number of

organisms recovered from the peripheral blood and the thoracic duct lymph. These authors showed that recovery was associated with bacteræmia, but in the development of peritonitis no organisms could be recovered from the blood and only few from the lymph. Gum tragacanth was used to decrease absorption and was uniformly associated with the development of fatal peritonitis.

Bruce Morton⁹ has, moreover, shown that a plastic exudate of any kind, excited by organisms, or by irritating chemicals, such as turpentine, markedly decreases absorption.

Various other methods of interfering with absorption so as to favor the production of peritonitis have been applied. Gum tragacanth has been used most frequently in this connection in the production of experimental peritonitis. Hermann obtained a higher incidence of peritonitis in experimental animals as a result of the injection of living bacteria in those animals which had received a previous injection of killed organisms.

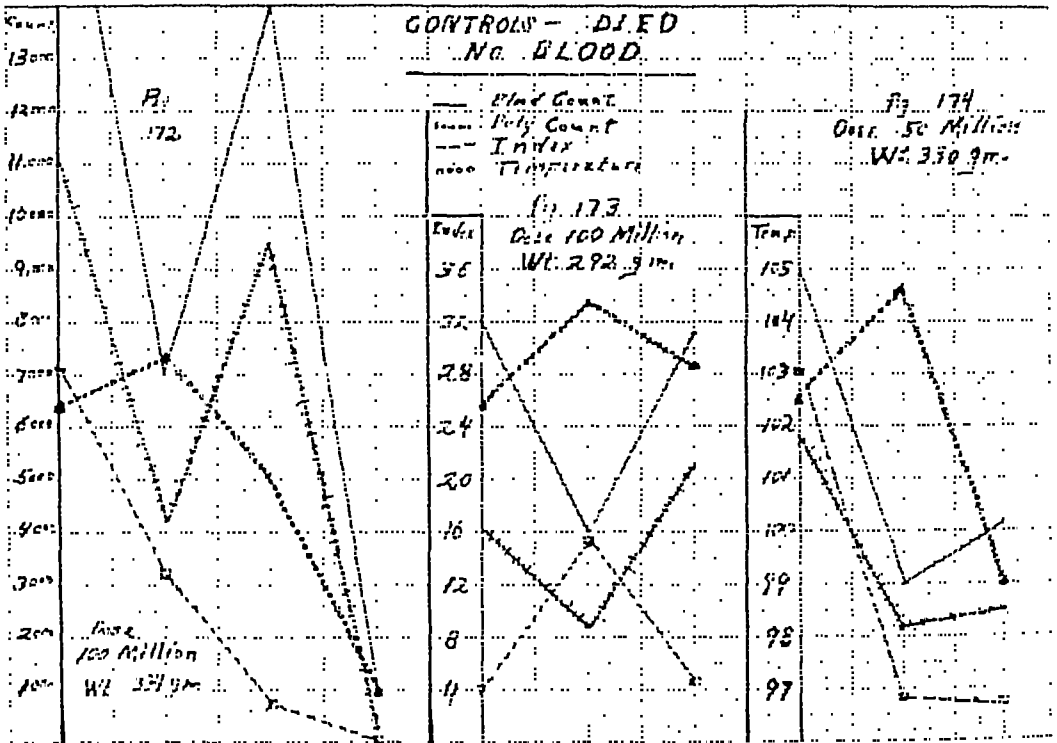


FIG. 2.

He believes that this is due to an increased local reaction rather than to a decrease in absorption. Hypertonic glucose and saline solutions have been studied by Reschke,¹¹ in 1921, as a possible means of decreasing absorption from the peritoneal cavity. The introduction of eight to nine grams of dry glucose placed in the peritoneum of rabbits through a laparotomy wound resulted in a decreased absorption of bacteria and toxins. Since high concentrations of sugar act as a bacteriostatic agent; it is difficult to draw conclusions from his results.

Starling and Tubby,¹⁴ in 1894, as well as Orlow,¹⁰ in 1895, showed that absorption is slowed in proportion to the concentration of organic material of fluids placed in the peritoneal cavity. These authors pointed out the fact that serum is very slowly absorbed from the peritoneal cavity.

From the foregoing results one would expect that blood should decrease absorption from the peritoneal cavity, since it sets up a local reaction and simultaneously increases the protein or organic content of the injected fluid.

EFFECT OF BLOOD IN EXPERIMENTAL PERITONITIS

From the previously cited experiments one would expect that these factors would favor the production of peritonitis when organisms are injected with or subsequent to the injection of blood.

Material and Methods.—Since Meleney⁷ has found that the colon bacillus is the organism most commonly found in peritonitis, we have used this organism throughout these experiments. Guinea-pigs were chosen for these experiments because they were found to react more uniformly than other laboratory animals.

In our early experiments two strains of colon bacilli isolated from the peritoneum of a patient operated upon for a ruptured appendix were used.

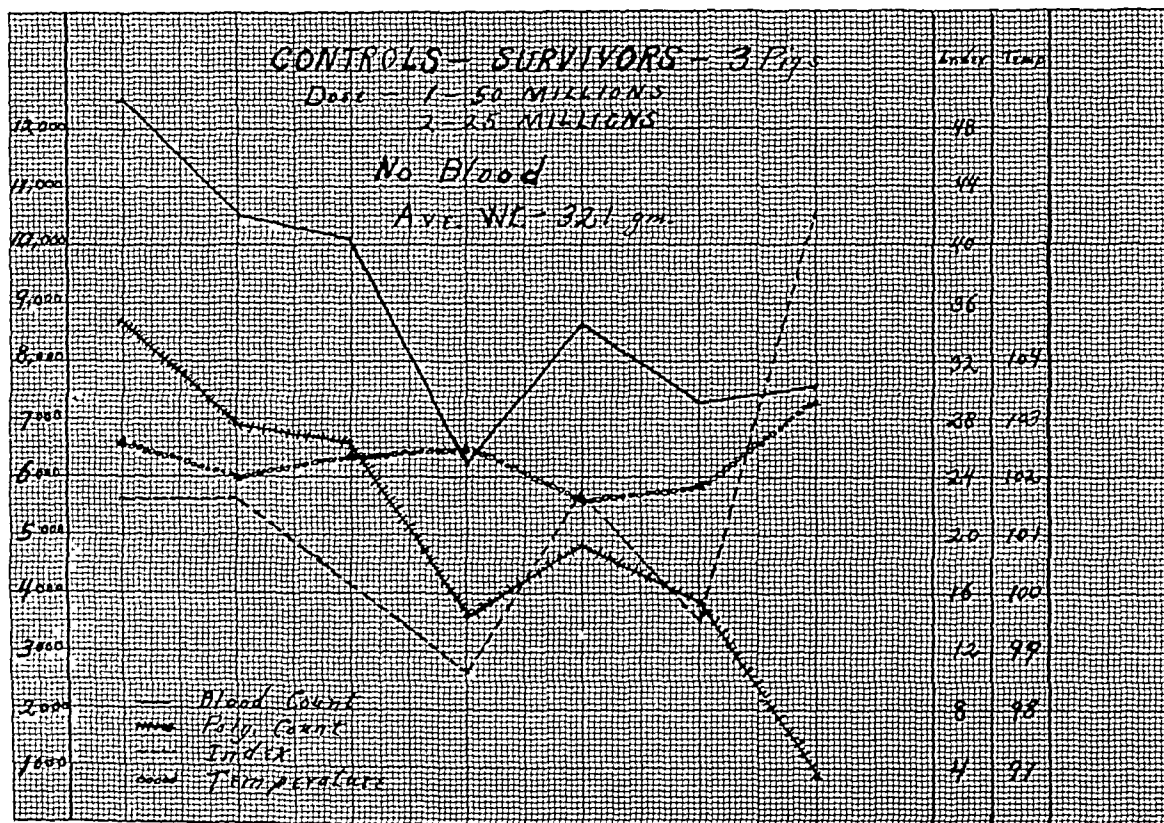


FIG. 3.

The results from the experiments using these strains were quite variable. Similar results were found using a strain (C-20) grown through several generations on laboratory media. Experiments with this strain, using larger or smaller amounts of broth culture, seemed to show that peritonitis and death would occur in a certain number of cases, but even the largest doses occasionally failed to produce peritonitis. Smaller doses might have the desired effect on one day and fail to produce peritonitis on the next. This confusion led to the employment of a wide range of dosage of organisms with inconclusive results.

In the earlier experiments two important factors were not controlled. Known amounts of broth cultures were used without regard to the number of bacteria present. There may be a wide variation in the bacterial count of broth cultures, ranging from 50 to 400 million bacteria per cubic centimetre in

the case of the colon bacillus. In order to control the number of bacteria used, a Gates turbidimeter was employed and all doses determined in terms of millions of bacteria.

The other factor not controlled in the earlier experiments was the variability of the toxicity of the strain used. It was desirable to have on hand a strain in which a fairly constant minimal lethal dose would always produce peritonitis. Various strains in the Pepper laboratory of the University Hospital were tested and two fairly satisfactory strains were found. Dr. Frank Meleney,⁸ of New York, kindly contributed two other strains, one of which was found very satisfactory. However, we noted that there was much vari-

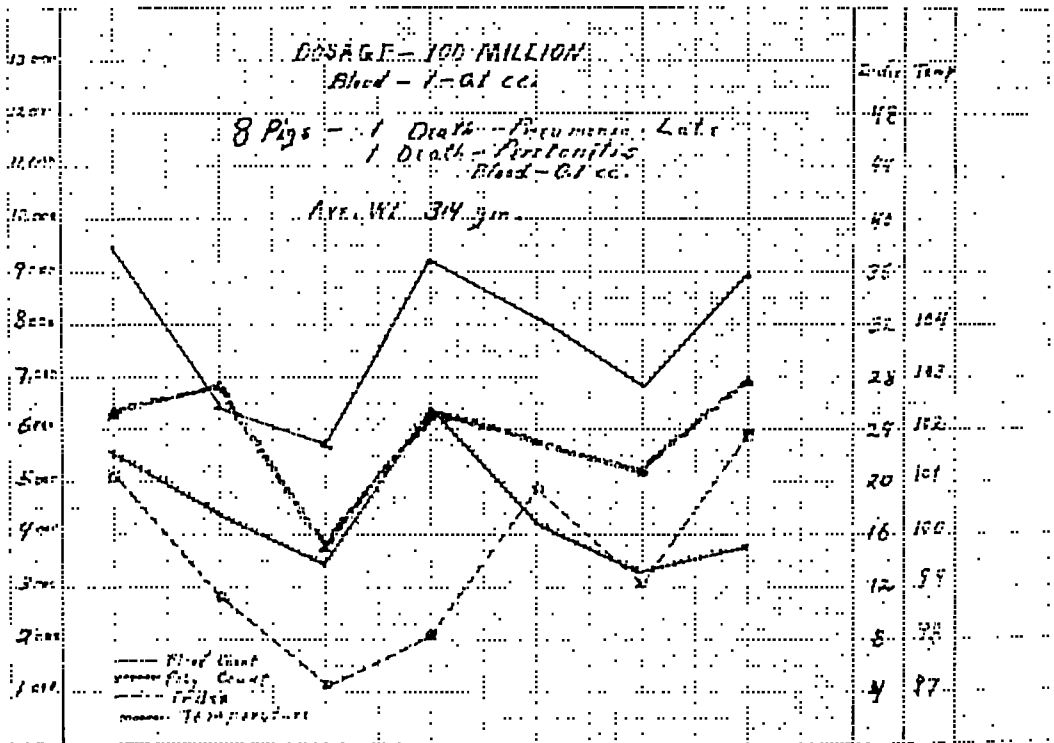


FIG. 4.

ability in the toxicity of the strains tested from Pepper laboratory, although they satisfactorily produced peritonitis. We had noted the development of substrains in most of the strains we had used, but we attached little significance to this phenomenon. Doctor Meleney called our attention to the significance and importance of the development of substrains in relation to variability in toxicity.

Substrain development, as we interpret it, is not the well-known dissociation of bacteria into smooth, rough and intermediate colonies, as described by Theobald Smith and others. There seems instead a definite separation into two substrains, and this seems to occur at any time as the organisms are growing or transferred on artificial media. One substrain is glistening white on its surface and opaque to transmitted light. This substrain of colon bacilli is always toxic when produced in a toxic strain. The other is dark on its sur-

EFFECT OF BLOOD IN EXPERIMENTAL PERITONITIS

face, but readily transmits light. It may be almost entirely non-toxic. Whenever this separation into substrains occurs and the non-toxic out-number the toxic colonies, the minimal lethal dose of the injected organisms will be much increased. It is then necessary to subculture from the toxic substrain to restore the toxicity. This explains the necessity of determining the minimal lethal dose of any strain on the day before its use to be reasonably sure that the expected effect will occur.

With these refinements in technic an experiment was devised accurately to determine the value of blood in experimental peritonitis. The minimal lethal dose of the strain used was determined as being slightly below 100

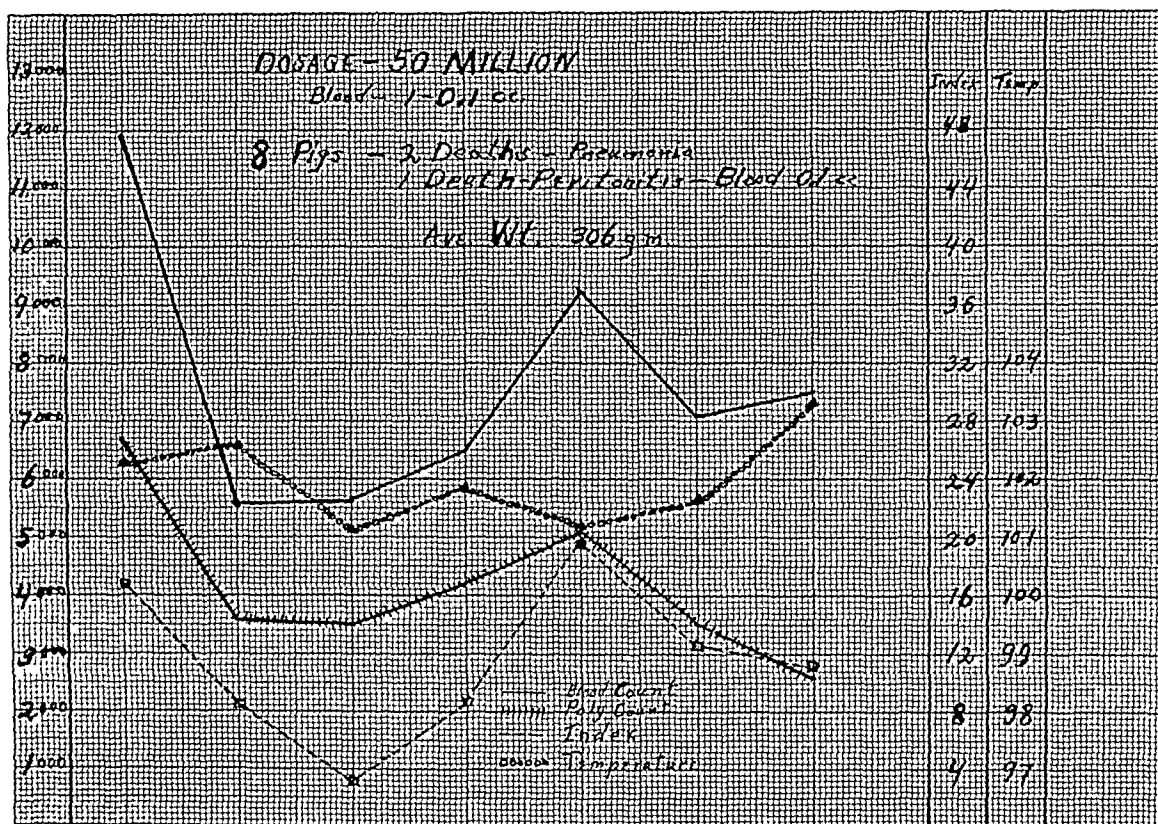


FIG. 5.

million bacteria for a guinea-pig of about 300 grams in weight. Six guinea-pigs were injected with doses of 400, 350, 300, 250, 200, and 100 million bacteria. All the animals died of peritonitis. The last, receiving 100 million bacteria, died in seventy-two hours with a severe plastic peritonitis. The remaining animals died in from two to four hours.

Thirty-four guinea-pigs were used next day, of which ten were used as controls. Blood counts, differential counts, including Schilling indices, were taken from ear veins. Rectal temperatures were taken and smears were made from the peritoneal cavity by needle puncture; all at similar intervals so that all data was collected as nearly simultaneously as possible. Injections were made with a tuberculin syringe through a 22-gauge needle. The animals had been on a uniform diet for some time before the experiment and their weight was nearly uniform. Housing, diet, and all other conditions

were kept uniform during the experiment. When an animal died it was autopsied as quickly as possible, cultures were taken from the peritoneum and microscopical sections were made of its viscera. Blood and peritoneal smears were stained with Ramonowski's stain. The total white blood-cell count and the total polymorphonuclear count were chosen for illustration with the Schilling index as giving the most significant findings. High percentages of monocytes were frequently observed in the differential count, but they were too variable to illustrate.

Autogenous blood was not used in these experiments. Defibrinated sheep's blood collected under sterile conditions was used instead. Broth cul-

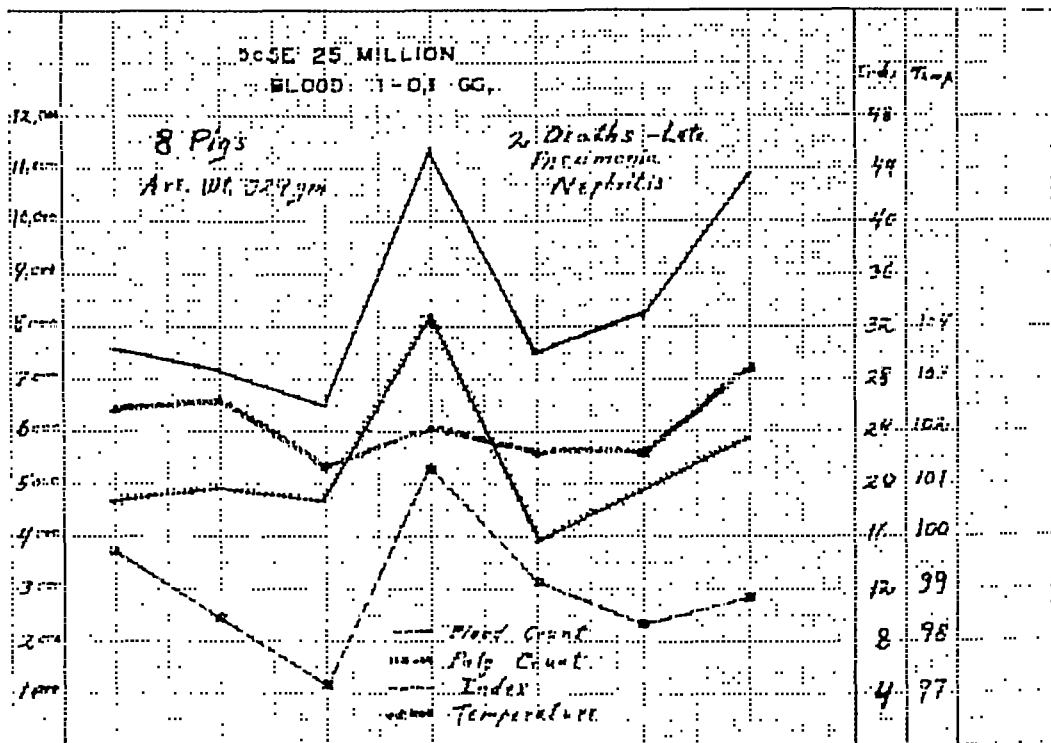


FIG. 6.

tures were thoroughly mixed and shaken, the count determined by the turbidimeter, and the calculated dosage injected simultaneously with blood. Sufficient amount of fluid could not be withdrawn from the peritoneal cavity for cell count without definitely changing dosage relationships, so only very minute amounts were used to make smears.

Results.—In the ten control animals the minimal lethal dose was between fifty and 100 million bacteria. Twenty-five million bacteria did not cause peritonitis or death in either of two animals in which no blood was injected in the peritoneum. When fifty million bacteria were injected, one of the two animals developed peritonitis and died. The six animals receiving 100 million bacteria or more all died of peritonitis.

Twenty-four animals received blood as well as bacteria. These were divided into three groups receiving 100, fifty and twenty-five million bacteria respectively. Each of these groups of eight animals was further subdivided into four groups of two animals receiving 0.1 cubic centimetre, 0.2 cubic centimetre, 0.5 cubic centimetre and one

EFFECT OF BLOOD IN EXPERIMENTAL PERITONITIS

cubic centimetre of defibrinated sheep's blood injected with the bacteria. Of those receiving 0.2 centimetre or more blood in the peritoneal cavity with the organisms, none died of peritonitis. Four animals of this group died of pneumonia and did not have peritonitis at death as evidenced by a study of microscopical sections. These animals lived for a period of two, six, nine, and eleven days following the injection of the organisms and blood.

Of the animals receiving only 0.1 cubic centimetre of blood with the organisms, one of the two animals receiving 100 million, and one of the two receiving fifty million bacteria developed peritonitis and died on the second and fifth days following the injection. Of the two animals receiving 0.1 cubic centimetre of blood and twenty-five million bacteria one died of pneumonia seven days after receiving the intraperitoneal injection. The mortality and occurrence of peritonitis are illustrated in Table I. When sufficient blood was injected with the organisms (0.2 cubic centimetre or more) the animals did not develop peritonitis even when a dose which killed all controls was injected.

TABLE I
Gross Mortality

| | Controls | | | |
|------------------|----------|-------|------|------|
| Dosage | 200 M | 100 M | 50 M | 25 M |
| Animals..... | 2 | 4 | 2 | 2 |
| Peritonitis..... | 2 | 4 | 1 | 0 |
| Deaths..... | 2 | 4 | 1 | 0 |

Experimental

a. 100 M Organisms

| Blood | 1 cc. | 0.5 cc. | 0.2 cc. | 0.1 cc. |
|------------------|-------|---------|---------|---------|
| Animals..... | 2 | 2 | 2 | 2 |
| Peritonitis..... | 0 | 0 | 0 | 1 |
| Deaths..... | 0 | 1 | 0 | 1 |

b. 50 M Organisms

| Blood | 1 cc. | 0.5 cc. | 0.2 cc. | 0.1 cc. |
|------------------|-------|---------|---------|---------|
| Animals..... | 2 | 2 | 2 | 2 |
| Peritonitis..... | 0 | 0 | 0 | 1 |
| Deaths..... | 1 | 0 | 1 | 1 |

c. 25 M Organisms

| Blood | 1 cc. | 0.5 cc. | 0.2 cc. | 0.1 cc. |
|------------------|-------|---------|---------|---------|
| Animals..... | 2 | 2 | 2 | 2 |
| Peritonitis..... | 0 | 0 | 0 | 0 |
| Deaths..... | 0 | 0 | 1 | 1 |

In the controls which died (Figs. 1 and 2) there was a general tendency to a temporary rise of two to three degrees Fahrenheit, in temperature, followed by a drop to below the normal level as the animal approached death. The Schilling index dropped in all fatal cases. Occasionally there was a temporary rise before the sudden drop occurred. The percentage of polymorphonuclear cells was not markedly disturbed in the fatal cases, although there was a drop in total count in nearly every instance.

In the three surviving controls (Fig. 3) the temperature was not so greatly altered. There was a temporary drop in the nuclear index, which later rose to above the normal level. There was a rise in the polymorphonuclear count at the end of twelve hours, but this dropped to a point well below normal by the end of eighty-four hours. The total

count rose rapidly after the injection and later dropped to the normal level. The discrepancy between the total count and the polymorphonuclear count represents a rise in the lymphocytes which continued to remain high.

The animals receiving 0.2 cubic centimetre or more of blood and 100 million bacteria showed a primary drop in temperature, Schilling index and total white blood-cell count, but there was a rapid return to normal with no disturbance of the polymorphonuclear percentage. (Fig. 4.). One of the animals receiving 0.1 cubic centimetre of blood and 100 million bacteria died of peritonitis within forty-eight hours. The findings in this animal were in general similar to the controls who died of peritonitis.

The curves obtained from the animals receiving fifty and twenty-five million bacteria with 0.2 cubic centimetre or more of blood are quite similar to that obtained from the corresponding group receiving 100 million bacteria. (Figs. 5 and 6.)

The high incidence of pneumonia (five of thirty-four) can be explained either on the bases of intercurrent respiratory infection, or upon the fact that the organisms, quickly passing from the peritoneum, set up foci in the lungs.

Peritoneal smears showed that in the fatal cases of peritonitis bacteria increased rapidly. In the control animals surviving, bacteria first increased, then decreased until at the end of eighty-four hours they were usually absent. Animals with blood in the peritoneal cavity showed a very rapid disappearance of bacteria, so that at the end of thirty-six hours no bacteria were found in the smear. The smears of these animals did not contain the large number of bacteria seen in those of the control animals. Table II shows typical findings in the smears of each group.

TABLE II
Peritoneal Smears

Guinea-pig No. 172. Injected intraperitoneally with 100 million bacteria. Result.—Death within twenty-four hours from peritonitis.

| | 2 hrs. | 4 hrs. | 12 hrs. |
|------------------------------|--------|--------|--------------|
| Polymorphonuclear cells..... | 28 | 63 | many |
| Lymphocytes..... | 3 | 0 | 0 per H.P.F. |
| Red blood-cells..... | 0 | 40 | many |
| Macrophages..... | 0 | 0 | 0 |
| Bacteria..... | 7 | many | innumerable |

Guinea-pig No. 171. Injected intraperitoneally with twenty-five million bacteria. Result.—Survived.

| | 2 hrs. | 4 hrs. | 12 hrs. | 36 hrs. | 60 hrs. | 84 hrs. |
|---------------------------|--------|--------|---------|---------|---------|---------|
| Polymorphonuclear cells.. | 3 | 115 | 47 | 84 | 53 | 3 |
| Red blood-cells..... | 4 | 30 | 0 | 0 | 0 | 0 |
| Macrophages..... | 0 | 3 | 4 | 14 | 31 | 31 |
| Bacteria..... | 1 | many | 30 | 5 | 50 | 0 |

Guinea-pig No. 179. Injected intraperitoneally with 100 million bacteria and one cubic centimeter of blood. Result.—Survived.

| | 2 hrs. | 4 hrs. | 12 hrs. | 36 hrs. | 60 hrs. | 84 hrs. |
|---------------------------|--------|--------|---------|---------|---------|---------|
| Polymorphonuclear cells.. | 44 | 222 | 150 | 32 | 67 | 3 |
| Red blood-cells..... | 137 | 832 | 61 | 103 | 22 | 3 |
| Macrophages..... | 0 | 0 | 4 | 2 | 6 | 0 |
| Bacteria..... | 1 | 9 | 2 | 0 | 0 | 0 |

Only one culture of the peritoneal cavity of autopsied animals was sterile and this was one of the animals receiving blood which died of pneumonia. The animals receiving

EFFECT OF BLOOD IN EXPERIMENTAL PERITONITIS

blood seemed to have less growth in the culture, but too many extraneous factors enter here to draw any conclusions from this fact.

The pathological sections of these animals were interesting. All showed mild nephrosis, cloudy swelling of the liver and acute splenitis. In the animals dying with peritonitis there was marked swelling and œdema of the peritoneum with occasional subserous infiltrations. Pneumonia was diagnosed only when the alveolar spaces were filled in the stage of either red or gray hepatization, since all lungs showed some engorgement and filled capillaries. All adrenals showed poorly stained cells with vacuolization. Some of the adrenals showed derangement of architecture as well and this was especially true when peritonitis was the cause of death.

In order to determine whether dilution of the injected organisms by blood was responsible for the variation in the results seen in the two groups of animals, a third group of six animals was used. These animals received 100 million bacteria diluted with 0.1 cubic centimetre to one cubic centimetre of sterile broth. All these animals died of peritonitis within forty-eight hours.

Discussion and Conclusions.—It would seem from these results that blood injected with organisms not only gives no predisposition to peritonitis but offers a moderate degree of protection against it, at least in the case of the colon bacillus. The control animals receiving a minimal lethal dose all died, yet only two of sixteen receiving a minimal lethal dose with varying amounts of blood died from peritonitis, and these animals received a small amount of blood. Certainly doses below the minimal lethal dose were not raised to minimal lethal by the employment of blood. That this effect was not the result of mechanical dilution was later proven by the addition of broth in varying quantities to minimal lethal doses of bacteria without effect. Peritoneal smears also indicate that blood seems to hasten the disappearance of bacteria from the peritoneum. This may be by reason of greater rapidity of absorption, or by increased rapidity of destruction of the bacteria. This power of protection is not sufficiently great, nor can analogy be drawn with sufficient clarity to human peritonitis to justify its clinical application in any way at present.

The results from these experiments would lead one to believe that the pleura and peritoneum as serous membranes do not respond in a similar manner to the presence of blood introduced with organisms, since Allen has shown that the addition of a small amount of blood increases the incidence of empyæma of the pleural cavity when certain organisms are injected.

Many thanks are due to Dr. F. B. Lynch, of the Pepper laboratory of the University of Pennsylvania Hospital, for his valuable suggestions and constant coöperation in preparation of cultures. We are also indebted to Dr. George Muller, whose suggestions and tolerance have made this work possible. The constant interest and supervision of Dr. I. S. Ravdin are also sincerely appreciated.

BIBLIOGRAPHY

¹ Allen, Duff: Surg., Gynec., and Obst., vol. xlv, p. 23, 1927.

² Clark, A. J.: Journ. Pharm. and Exp. Ther., vol. xvi, p. 415.

³ David, V. C., and Sparks, J.: ANNALS OF SURGERY, vol. lxxxviii, p. 672, October, 1928.

- ⁴ Florey, H. F., and Witts, L. J.: *Lancet*, vol. i, p. 1323, June, 1928.
- ⁵ Gates, F. L.: *Jour. Experimental Med.*, vol. xxxi, p. 105, January, 1920.
- ⁶ Hermann, S.: *Arch. Surg.*, vol. xviii, p. 2282, May, 1929.
- ⁷ Meleney, F. L., Harvey, H. D., and Jern, H. Z.: *Arch. Surg.*, vol. xxii, pp. 1-66, January, 1931.
- ⁸ Meleney, F. L.: Personal communications.
- ⁹ Morton, Bruce: *Am. Jour. Med. Sci.*, vol. clxxiii, p. 274, 1927.
- ¹⁰ Orlow, W. N.: *Arch. f. Physiol.*, vol. lix, p. 170, 1895.
- ¹¹ Reschke, Karl: *Arch. f. klin. Chir.*, vol. cxvi, p. 466, 1921.
- ¹² Schumann, Edward: New York, 1921.
- ¹³ Sparks, J., and David, V. C.: *Surg., Gynec., and Obst.*, vol. xlviii, p. 780, 1929.
- ¹⁴ Starling, E. H., and Tubby, A. H.: *Jour. Physiol.*, vol. xvi, p. 140, 1894.
- ¹⁵ Steinberg, B., and Goldblatt: (a) *Arch. Int. Med.*, vol. xxxix, p. 446, 1927; (b) *Arch. Surg.*, March, 1932.
- ¹⁶ Sweet, J., and Smythe, C., Jr.: Personal communications.

TRAUMATIC ULNAR NEURITIS

WITH ESPECIAL REFERENCE TO THE LATE OR TARDY ULNAR PARALYSIS

BY FRANCIS M. CONWAY, M.D.

OF NEW YORK, N. Y.

FROM THE SURGICAL SERVICE OF THE HARLEM HOSPITAL

THE lesions in which a disturbance of the normal relation between the ulnar nerve and its nerve bed exists may be grouped under the general heading of "Traumatic Neuritis." In considering lesions of the ulnar nerve under this classification, gross injuries may be excluded and attention confined to those cases in which trauma in the region of the elbow has resulted in the gradual onset of a neuritis.

By virtue of its location behind the elbow-joint, the ulnar nerve is subject to many potential disadvantages. Owing to its short course in that location, the nerve is slightly stretched with each motion of flexion but intrinsic elasticity and mobility allow it to undergo these momentary changes without suffering any damage. This compensatory mechanism may be disturbed if the nerve itself is traumatized or if the bed on which it lies be distorted in any way. Under such circumstances, a neuritis is induced by a repetition of normal movements—movements which otherwise would produce no untoward effect.

Exaggerated mobility, an anomaly which exists in a certain unknown number of individuals where the hypermobile nerve slips forward on the epicondyle, may also affect the ulnar nerve adversely. If the dislocation becomes complete and occurs with every movement of flexion, the nerve is almost certain to undergo some damage and a "friction neuritis" be sustained. Platt has distinguished the following clinical groups in this series of lesions and has outlined them as follow:

(1) *Primary neuritis:*

(a) Following simple contusions

(b) Complicating:

(i) Internal epicondylar fractures

(ii) Supracondylar fractures

(iii) Dislocation of the elbow

(2) *Secondary neuritis:*

(a) Complicating:

(i) Fractures of the lower end of the humerus

(ii) Dislocations of the elbow-joint

(3) *Delayed neuritis:*

(a) With resultant late ulnar palsy as the sequel of external condylar fractures

(b) Following recurrent dislocation of the nerve. It is with this third group of so-called delayed neuritis with the late ulnar palsy that we have to do.

It is believed that Duchenne was familiar with the condition, but as far as can be definitely ascertained, it was first described by Panas, in 1878. He described the lesion in an individual twelve and one-half years after his original injury about the elbow. Broca and Mouchet, in 1899, presented a most comprehensive investigation of the subject in the form of a study of the nerve lesions complicating certain fractures of the lower end of the humerus. Mouchet himself, in 1898, in an earlier paper, had drawn attention to this delayed type of ulnar nerve lesion and had realized that the injury which preceded it was almost invariably a fracture of the external epicondyle of the humerus. Since that time, Mouchet has made several valuable additions to this subject. Prior to 1900, cases were reported by Bowlby, Weber, Guillemain and Mailly and to this period belongs the first of Mouchet's illuminating contributions. More recently, Platt has reviewed the literature and presented several cases of late ulnar paralysis successfully treated by the method of anterior transplantation of the nerve.

Pathogenesis.—In Mouchet's opinion, the classical late ulnar nerve lesion is unlikely to be associated with other varieties of humerus fracture other than those of the external condyle because the development of the paralysis is determined primarily by the existence of a gross cubitus valgus deformity. Now this deformity, in an extreme degree, is a characteristic sequel of the complete external condylar fracture and no other, although an increase in the carrying-angle is not infrequently present after supracondylar fractures or internal condylar fractures. It may be said that the scrutinizing of the radiographs of cases reported in the last decade bears out the accuracy of Mouchet's conception, that the late ulnar nerve lesion is ordinarily a sequel of fractures of the external condyle.

The initial injury is sustained in early life and usually between the ages of two and ten years. In the typical case, the fracture involves the external condyle of the humerus with the line of cleavage running obliquely into the elbow-joint. This is a familiar fracture in children and one which gives rise to difficulty owing to the tendency of the large fragment to be turned on its axis by the pull of the extensor attachments. It appears to be the rule for the fracture to unite by fibrous tissue only. In many cases, the functional result as regards joint function and mobility is fairly satisfactory. The cubitus valgus usually manifests itself at a comparatively early stage but often excites little or no comment at the time. In adult life, the distortion is always conspicuous and is due to the irregular epiphyseal growth being added to the initial displacement already present in the condyle. There is what may be termed a "latent period" in this condition, for, in about 75 per cent. of the recorded cases, the interval between the initial injury and the onset of the first signs of nerve involvement is not less than ten years.

Latent periods of thirty years are not uncommon and in the case herein reported the intervening time was twenty years. As a rule, during this time no change in the elbow is noted other than the steady increase in the degree of the deformity which reaches its maximum with the cessation of growth of the epiphyses. The cubitus valgus is a striking deformity and with the distortion of the lower end of the humerus gives a false impression of over-growth of the internal condylar region. It is this appearance which has so

TRAUMATIC ULNAR NEURITIS

often been responsible for the erroneous clinical diagnosis of "old fracture of the internal epicondyle." The ulnar groove is found to be relatively shallow and in it the tender, thickened nerve trunk appears to lie in an unusually exposed and superficial position.

Neuropathology.—Grossly, the nerve trunk is swollen, often irregularly, along a portion of its course. This thickening may extend as far as two inches proximally and distally to the ulnar groove. In the early stages of compression, the nerve is soft, succulent and hyperæmic in appearance and may contain lymph between its bundles. In the later stages, it becomes firmer from the overgrowth of fibrous tissue and local induration may become more marked with the formation of a spindle-shaped neuroma.

On microscopical examination, the picture of a chronic interstitial neuritis may be seen. The peri- and endoneural sheaths show a greater or less degree of infiltration with round cells and proliferation of the connective tissue and endothelial cells. The vessels are congested and their walls filled with cells of various kinds, plasma cells, lymphocytes and polymorphonuclears predominating. As one passes to the later stage of the process, connective-tissue overgrowth assumes the chief rôle, and the cellular infiltration becomes less marked. The nerve fibres themselves may be pressed upon by the lymphocytic infiltration or the overgrowth of the fibrous tissue and undergo changes similar to those of a parenchymatous neuritis. Fortunately, however, even though there is degeneration of the medullary sheaths of the nerves, the axones tend to persist, and thus the function is rapidly restored once the inflammatory products are completely removed.

Symptomatology.—The late neuritis of the ulnar nerve does not differ in symptomatology from the other forms of progressive neuritis. The symptoms arise insidiously and progress steadily. The neurological symptoms in the initial phase will vary with different individuals. As is usual, with compression, the motor fibres are more vulnerable than the sensory fibres and for that reason motor symptoms dominate the clinical picture and often precede any evidence of sensory involvement. Usually there is an atrophic paralysis of gradual development with changes in the electrical excitability corresponding to the degree and duration of the muscle degeneration. The sensory symptoms, both subjective and objective, may be very slight and when present are typically along the course of the ulnar nerve distribution. Even in the advanced cases, the anæsthesia is of the epicritic type, the protopathic sensibility being well-preserved. The objective signs progress from those of an incomplete nerve block to evidence of a complete interruption whence paresis and atrophy of the hand musculature are soon manifest.

In the absence of pain, this scarcely perceptible disturbance of tactile sensibility may be overlooked and lead to the suspicion of progressive muscular atrophy, and especially so since the wasting of the small muscles of the hand is slowly progressive. Here, however, the absence of fibrillary twitchings and the strict limitation of the atrophy to the ulnar nerve distribution, together with the disturbances of sensibility, should be enough to make the diagnosis clear.

With interruption of the ulnar nerve conduction at the elbow, a well-recognized picture will be seen as follows:

(1) Analgesia or loss of protopathic sensation of the fifth finger and the ulnar border of the palm, dorsal and palmar, but seldom of the ring finger; anæsthesia to light touch (loss of epicritic sensation) of the ulnar side of the dorsum of the wrist and palm, of the dorsal and palmar aspects of the hand and of the little and ring fingers.

(2) (a) Paralysis of the flexor carpi ulnaris causing weakness in flexion and in ulnar adduction of the wrist.

(b) Paralysis of the inner half of the flexor profundus digitorum, with resultant weakened hand-grasp, especially in the ring and little fingers.

(c) Paralysis of the two inner lumbricales, all of the interossei and hence loss of adduction and abduction of the fingers, with flexion of the last two phalanges in each finger and hyperextension of the metacarpo-phalangeal joint, giving the "claw-hand." The interosseous spaces become very evident as a result of atrophy of these muscles.

(d) Paralysis of the short muscles of the fifth finger; of the inner group of the short thumb muscles (adductor transversus and adductor obliquus) and the deep portion of the flexor pollicis brevis and palmaris brevis.

Treatment.—The treatment will have to satisfy the two canons of the ideal neurolysis: First, the course of the nerve must be shortened, and secondly, the nerve must not be placed where scar tissue will reform and compress it. It is obvious that the only treatment indicated to relieve the condition is surgical interference in an endeavor to free the nerve of compression in the medial epicondylar groove. Mouchet, in his article in 1914, outlined four methods of procedure as being worthy of consideration. The first method was merely a simple freeing of the nerve from its bed and was performed by Potherot, in 1897, in Mouchet's first case. This type of intervention is open to serious question since by merely freeing the connective tissue about the neural groove without any other procedure one invites the formation of more scar tissue and the prime purpose of the operation is defeated. The second method consisted in the gouging out of a posterior condylar groove and placing the ulnar nerve in this newly formed channel. This procedure is criticized for two reasons: first, because it is unwise to replace the nerve in a freshly prepared bed where fibro-osseous scar tissue will form without expecting more compression of the nerve and further trouble; secondly, the course of the nerve is not shortened to any appreciable degree. A third method, which has not been widely used and which sought to correct the cubitus valgus at the same time as the nerve compression, was a supra-condylar osteotomy of the lower end of the humerus with the removal of a triangular wedge. The fourth method, and the one which has much to recommend it not only because it satisfies the postulates of a neurolysis but also because of its relative simplicity, is that of transplantation of the ulnar nerve from the ulnar groove anteriorly to the medial epicondyle. This method has proven uniformly successful.

CASE REPORT.—E. P., a white German housewife, aged twenty-two years, was admitted to the Surgical Service of Dr. John F. Connors at the Harlem Hospital Sep-

TRAUMATIC ULNAR NEURITIS

tember 30, 1931, with the complaint of progressive weakness of the right hand, contracture of the fingers and diminished sensation of the fourth and fifth fingers of eight months' duration. In January, 1931, she noticed for the first time that she could not fully extend the fourth and fifth fingers and that power and grip in those members were becoming increasingly weaker. This loss of power was especially noticeable when she attempted to



FIG 1—Photograph taken prior to operation showing the marked degree of cubitus valgus, contracture of the fingers and atrophy of the intrinsic musculature of the hand (Photograph taken October 1, 1931)

do her housework and tried to lift objects with that hand. She states that the weakness has persisted longer than the anæsthesia and the contracture; in fact, it was the sensation of numbness and tingling in the fingers that brought her to the hospital for relief. There has never been any swelling or pain. Her past history is irrelevant except for an injury she received in the region of her right elbow at the age of two years and for which she



FIG 2—Photograph showing dorsal aspect of the right hand and the extent of contracture of the fingers as compared with the normal hand.

was treated in a surgical clinic in Germany (1911). She was a healthy young woman with a marked cubitus valgus deformity of the right elbow and atrophy and contracture of the last two fingers of the right hand. (Figs. 1 and 2.) The hand shows the typical picture of the lesion resulting from pressure on the ulnar nerve at the elbow with characteristic analgesia and anæsthesia of the fourth and fifth fingers; weakened hand grip owing to a partial paralysis of the flexor profundus digitorum; hyperextension of the

metacarpo-phalangeal joints with the "claw-hand"; loss of the power to abduct and adduct the fingers with atrophy of the interossei.

Laboratory findings.—Temperature on admission, 99.0; pulse: 80; urinalysis: negative; blood Wassermann: negative; hæmoglobin: 90 per cent.; red blood-cells: 4,650,000; white blood-cells: 10,200; 80 per cent. polymorphonuclear leucocytes.

Radiographical findings reported an old fracture of the external condyle with a marked cubitus valgus deformity. (Figs. 3 and 4.) A photograph was also taken of the affected hand to show the extent of the atrophy of the intrinsic hand musculature. (Fig. 5.)

Despite the marked degree of deformity present at the elbow the flexion and extension were remarkably good.

A pre-operative diagnosis of tardy ulnar paralysis was made and operation decided upon in order to free the nerve and transplant it. October 1, 1931, operation was performed as follows: A seven-inch incision was made over the medial epicondyle extending



FIG. 3.

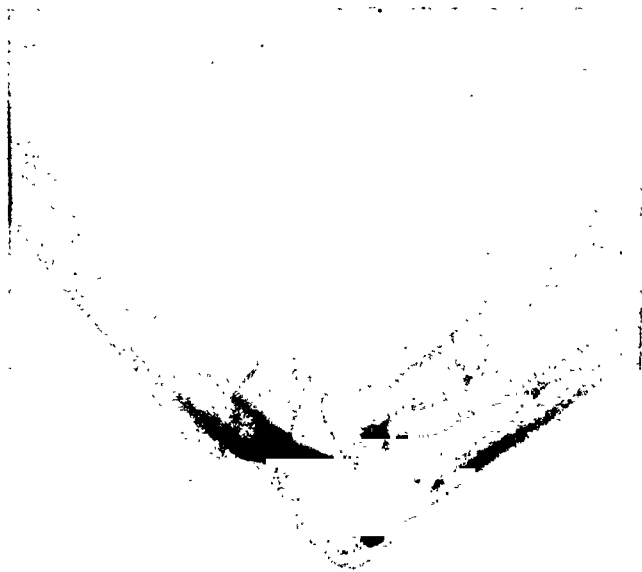


FIG. 4.

FIGS. 3 and 4.—Radiographs of the affected extremity showing the characteristic picture of an old fracture of the external condyle of the humerus with a partial rotation of the fragment. The original trauma causing the fracture occurred twenty years prior to the development of symptoms of ulnar palsy.

about three and one-half inches above and below that point. The soft tissues were divided and all bleeding points secured. The ulnar nerve was seen in its usual place and located at a point where it entered the ulnar groove of the medial epicondyle. A tape was then placed about the nerve trunk. On following the nerve along its course, a firm band of fibrous tissue was seen, causing the nerve to be adherent to the groove of the epicondyle. This was freed and the nerve trunk observed to be enlarged to about twice the normal diameter. At this point, for about one inch, the nerve was seen to be red, injected and somewhat more succulent in appearance. It was freed from the groove and brought anteriorly to rest upon the common origins of the flexors of the forearm. The arm was then extended to full extension and the nerve found to be loose and freely movable. For this reason it was not deemed advisable to divide the flexor carpi ulnaris. In order to prevent dislocation of the nerve, a tunnel was fashioned from the deep layer of the superficial fascia of the forearm and the nerve enclosed within this. The super-

TRAUMATIC ULNAR NEURITIS

ficial fascia was then brought together with No. 0 plain catgut and the skin edges closed with one continuous horsehair suture.

Owing to the fact that the patient was four months' pregnant, the operation was performed under local anaesthesia using 1 per cent. novocaine to infiltrate.

Her post-operative course was entirely satisfactory and she was discharged from the hospital on her third post-operative day. An inspection of the wound at that time

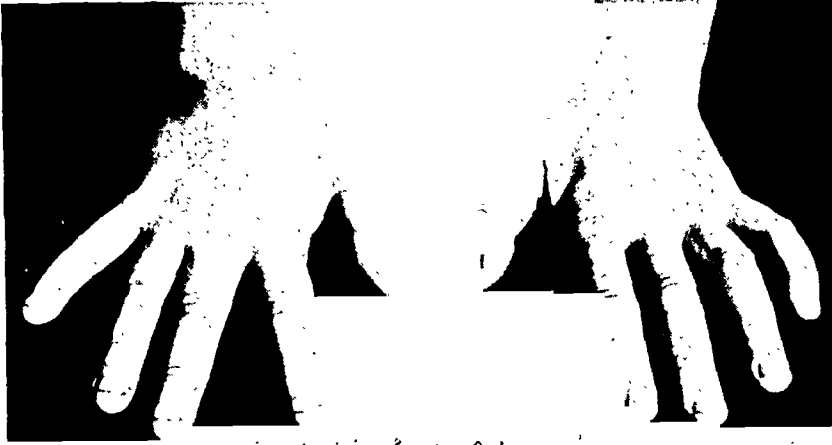


FIG. 5.—Photograph taken on November 23, 1931, on the fifty-third day after the anterior transplantation of the ulnar nerve. The claw-like appearance of the hand has largely disappeared, the interosseous spaces are not so prominent and complete sensation has returned to the ring finger.

showed the suture line to be intact and without infection. She was seen in the follow-up clinic on the ninth post-operative day and at that time the sutures were removed, the wound having healed by primary union.

She was seen October 14, 1931, and a note made that "the claw-like appearance of the hand had decreased somewhat. The patient states that there has been some return



FIG. 6.—Post-operative photograph taken to demonstrate the increase in power to flex fingers and the grip present after transplantation of the ulnar nerve. At the present time, there is little difference in power in the two hands. (Photograph taken December 21, 1931.)

of power in the affected hand." Slow muscle stimulation by means of the sinusoidal current was started.

November 6, 1931, the following note was made: "Sensation has returned to the fourth finger. The grip has returned in her hand so that she can now do her housework without difficulty. The interosseous spaces are not so prominent, indicating some return

in size of the interossei muscles. The claw-like appearance has largely disappeared. There is still a sensation of numbness in the fifth finger but the patient thinks that this is less than prior to her operation. There is still a prominence in the web-space between the thumb and the index finger."

At the time of her last visit, November 23, 1931, the hand presented objectively the same picture as that reported on November 6. She has been given sinusoidal treatments three times weekly and advised to use her hand as much as possible. This régime will continue for at least six months.

The striking feature in the post-operative course has been the diminution in the contracture of the hand and the rapidity of the return of power in that member.

CONCLUSIONS.—(1) The lesions in which a disturbance of the normal relation between the ulnar nerve and its nerve bed exists may be grouped under the general heading of "traumatic neuritis." The clinical entity of late ulnar palsy is then to be regarded as being within this group.

(2) The condition is not common but is easily diagnosed in the light of a history of an old fracture about the elbow followed years later by increasing weakness and atrophy of the hand. The original fracture is almost invariably a fracture of the external condyle of the humerus which was sustained in childhood.

(3) Of all the methods of surgical intervention, that of transplantation of the ulnar nerve is by far the simplest and has given the most striking results.

(4) In the case herein reported, the original fracture occurred twenty years before the development of symptoms and definite objective and subjective improvement was manifest as early as two weeks following the anterior transplantation.

BIBLIOGRAPHY

- Panas, J.: Sur une cause peu connue de paralysie du nerf cubital. *Arch. gén. de méd.*, vol. ii, Paris, 1878.
- Mouchet, A.: Fractures de l'extremite inferieure de l'humerus avec radiographies. Paris Thesis, 1898; These de doct., December, 1898.
- Guillemain, et Mailly: Compression du nerf cubital par un cal vicieux du coude, paralysie et reaction de degenerescence. Desenclavement. Guérison. *Cong. franc. de chir.*, p. 676, Paris, 1899.
- Broca, et Mouchet: Complications nerveuses de l'extremite inferieure de l'humerus. *Rev. de chir.*, vol. xix, Paris, June, 1899.
- Drouard, H.: Luxation et subluxation du nerf cubital. J. B. Bailliere et Fils, Paris, 1896.
- Murphy, J. B.: Indications for the Technic of and Results in Surgery of the Peripheral Nerves. *Illinois Med. Jour.*, October, 1907.
- Cobb, F.: Recurrent Dislocation of the Ulnar Nerve. *ANNALS OF SURGERY*, September, 1908.
- Sherren, J.: Remarks on Chronic Neuritis of the Ulnar Nerve Due to Deformity in the region of the Elbow-joint. *Edinburgh Med. Jour.*, vol. xxiii, p. 500, June, 1908.
- Mouchet, A.: Paralysie tardive du nerf cubital a la suite des fractures du condyle externe de l'humerus. *Jour. de Chir.*, vol. xii, p. 437, Paris, 1914.
- Platt, H.: The Operative Treatment of Traumatic Ulnar Paralysis. *Surg., Gynec., and Obst.*, vol. xlvii, p. 822, Chicago, 1928.
- Buzzard, E. F., and Greenfield, J. G.: Pathology of the Nervous System. Paul R. Hoeber, pp. 222-226, New York, 1925.

TRAUMATIC ULNAR NEURITIS

- Gamet, P. L. E.: Des troubles nerveux consecutifs aux lesions du nerf cubital. These de la Fac. de med. de Paris, No. 376, vol. xxi. 1899.
- Platt, H.: The Pathogenesis and Treatment of Traumatic Neuritis of the Ulnar Nerve in the Post-condylar Groove. *Brit. Jour. Surg.*, vol. xiii, pp. 409-431, January, 1926.
- Cotton, F. J.: Elbow Dislocation and Ulnar Nerve Injury. *Jour. Bone and Joint Surg.*, vol. xi, pp. 348-352, April, 1929.
- Hunt, J. R.: Tardy or Late Paralysis of the Ulnar Nerve. *Jour. Am. Med. Assn.*, p. 1032, January 1, 1916.
- Platt, H.: The Surgery of Peripheral Nerve Injuries in Warfare. Hunterian Lectures, John Wright and Sons, Bristol, December, 1921.
- Adson, A. W.: The Surgical Treatment of Progressive Ulnar Paralysis. *Minnesota Med.*, December, 1918.
- Hunt, J. R.: The Thenar and Hypothenar Types of Neural Atrophy of the Hand. *Am. Jour. Med. Sci.*, February, 1911.
- Buzzard, E. F.: Some Varieties of Traumatic and Toxic Ulnar Neuritis. *Lancet*, pp. 317-318, February 18, 1922.
- Murphy, J. B.: Indications for the Technic of and Results in the Surgery of Peripheral Nerves. *Illinois Med. Jour.*, October, 1907.
- Lewis, D., and Miller, E. M.: Peripheral Nerve Injuries Associated with Fractures. *ANNALS OF SURGERY*, pp. 528-539, October, 1922.
- Guerrini, F.: Periarthritis osificante con inclusion del nervio cubital. Transplante del nervio. *Bol. y Trabaja. de la Soc. de cirug. de Buenos Aires*, vol. xiii, April 17, 1929.
- Keschner, and Berman: Tardy or Late Ulnar Paralysis, with Report of a Case Developing Thirty Years after Fracture at Elbow. *Med. Jour. and Record*, vol. cxxxii, pp. 480-483, November 19, 1930.
- Brown, K. P.: Traumatic Ulnar Neuritis. *Edinburgh Med. Jour.*, vol. xxxvii, pp. 97-101, February, 1930.
- Platt, H.: On the Peripheral Nerve Complications of Certain Fractures. *Jour. Bone and Joint Surg.*, vol. x. p. 403, 1928.
- Lusena, M.: Le paralisi del nervo cubitale successive a fratture dell'estremo distale dell'omero. *Chirug. d. org. di movimento*, vol. vi, fasc. 2, pp. 139-164, Bologna, April, 1922.
- Sheldon, W.: Tardy Paralysis of the Ulnar Nerve. *Med. Clin. N. Amer.*, pp. 498-509, September, 1921.
- Gregoire, R.: Paralysie tardive du nerf cubital a la suite d'une fracture du condyle externe de l'humerus. *Bull. et mém. Soc. nat. de chir.*, pp. 232-236, Paris, February 13, 1924.
- Miller, E. M.: Late Ulnar Nerve Palsy. *Surg., Gynec., and Obst.*, vol. xxxviii, pp. 37-46, Chicago, 1924.
- Le Clerc, P.: Fracture ancienne du coude (condyle externe): paralysie cubitale tardive deux ans et demi apres le traumatisme). Transposition du nerf cubital. Guérison. *Soc. de chir. de Lyon*, January 9, 1913.

THE TREATMENT OF SARCOMA OF THE LONG BONES*

BY WILLIAM B. COLEY, M.D.

OF NEW YORK

DURING the past decade and a half, there has been an increasing interest in the subject of bone sarcoma, as manifested by the numerous papers and monographs that have been published both here and in Europe. Four books on the subject have appeared within the last four years, two of them by French authors, and one, the admirable work of Geschickter and Copeland, is based upon a study of a large number of cases observed at the clinic of Doctor Bloodgood at Johns Hopkins Hospital. Yet, in spite of this growing interest and voluminous writing, the treatment of bone sarcoma, especially of sarcoma of the long bones, remains in a most chaotic, unsettled state. The surgeon who, today, has to deal with a sarcoma of a long bone, even though he is acquainted with the literature on the subject, finds it most difficult to decide upon the method of treatment to be employed.

In 1921, at a symposium on bone sarcoma held during the Philadelphia meeting of the American College of Surgeons, Besley, of Chicago, stated that of twenty cases of bone sarcoma that he had treated by amputation, all that he had been able to trace, regardless of the histological type, had died; and that he had performed his last amputation for bone sarcoma. Six years later, a distinguished professor of pathology in New York who had made an extensive study of malignant tumors told me that if he personally were afflicted with a bone sarcoma, regardless of the histological type, even giant-cell tumor, he should have an immediate amputation performed.

Bone sarcoma is such a comparatively rare disease that the average surgeon sees no more than one or two cases, perhaps not even that many, in a year; and the average large city hospital admits not more than four or five cases annually. In the opinion of Forschell there are never more than twenty cases of sarcoma of the long bones in all Sweden at any given time.

It might be supposed that a study of the large amount of material collected by the Bone Sarcoma Registry of the American College of Surgeons would help one to select the best method of treatment; and yet after reading Kolodny's¹ critical review of this material, one must admit that he has gained little of practical value, and that Kolodny leaves one almost as pessimistic as did Butlin more than a generation ago. To quote Kolodny: "In bone sarcoma as in other malignant tumors the question of the therapy is still awaiting its answer. It is a strange fact that with our knowledge of minute details of the histopathology of bone tumors the progress along the practical therapeutic road is almost in the same stage that it was in some fifty years ago. As a rule malignant bone tumors are fatal and we know of no therapeutic method to prevent death from this disease."

* Observed in the Bone Sarcoma Department of the Memorial Hospital and the Hospital for Ruptured and Crippled of New York.

TREATMENT SARCOMA LONG BONES

Crile,² in his recent paper on the Treatment of Malignancy, based on an experience in 7,390 cases of malignancy, discusses the treatment of malignant tumors of bones in a few lines, as follows:

Exclusive of carcinoma of the jaw, we have seen 161 cases of malignant disease of bone. It is still uncertain whether a primary malignancy of bone should be treated by X-ray or by surgery, but two things are certain: First, if an operation is performed, it should be preceded and followed by X-ray radiation; and second, if the condition is in a limb, amputation should immediately follow radiation, provided the condition is not inoperable. As for metastatic tumors, palliative treatment by the X-ray is the only therapeutic measure. Radium is contra-indicated as it would destroy the periosteum, and necrosis would follow.

The data which are being accumulated by the Registry of Bone Sarcoma of the American College of Surgeons may finally lead to a decision as to the relative merits of surgery and of radiation in the treatment of malignant diseases of bone.

In other words, the material of the Cleveland Clinic furnishes no help in trying to decide on the best method of treating sarcoma of the long bones.

Turning to the foreign literature, we find that Nové-Josserand and Tavernier,³ in their book on Malignant Tumors of Bones, state that they are not impressed with the results obtained by radiation; that this method is rarely employed in a systematic manner, and that, so far, it has usually been limited to inoperable cases after failure of surgical treatment. In a later paper, however, one of these authors (Tavernier⁴) reaches a more favorable conclusion as to the value of irradiation in the treatment of osteogenic sarcoma. He states: "All the osteosarcomas that I have treated by surgical methods, even the most radical, have died of metastases after varying periods not exceeding five months. Only one has survived the period of five years, and in this case the diagnosis was doubtful; I myself considered it a benign tumor at the time of operation, although on histological examination it presented features of a spindle-cell sarcoma; the prolonged survival after resection makes me doubtful of the diagnosis. In view of these disastrous results I have tried radio-therapy in ten cases: three have remained well for three years, one for one year, three are recent cases, and three proved failures."

In the most recent book written on Tumors of Bones, Sabrazes, Jeanneney and Mathey-Cornat⁵ express the opinion that every patient afflicted with osteogenic sarcoma succumbs to the disease within a few months to two or two and one-half years, and that a mutilating operation is but very rarely followed by a longer survival. As regards the treatment of osteogenic sarcoma by irradiation, they believe the present statistics are too incomplete to justify any conclusions. Contrary to the opinion expressed by Tavernier, these authors state: "While certain osteogenic sarcoma which we ourselves have treated by irradiation have shown temporary amelioration for a month or two, they have thereafter become rapidly worse, the disease recurring and becoming generalized."

A study of the end-results obtained at Johns Hopkins Hospital, cited in the recent book of Geschickter and Copeland,⁶ shows that the writers I

have quoted are unduly pessimistic. I believe that a study of the end-results obtained at the Memorial Hospital and the Hospital for Ruptured and Crippled will prove even more convincing, and will help to eradicate the present attitude of hopelessness as regards the prognosis in malignant tumors of the long bones.

Classification.—Before deciding on any method of treatment of sarcoma of the long bones it is important to determine (1) whether we are dealing with a malignant tumor or a benign tumor; and (2) if malignant, what type of tumor it is.

While the ideal classification of bone sarcoma has not yet been reached, that of the Bone Sarcoma Registry of the American College of Surgeons is, perhaps, the best available. For practical purposes, however, it is too complicated and divides the main group of bone sarcomas into too many different types. All the surgeon needs to know is (1) whether the tumor in question is a periosteal or a central sarcoma; (2) whether it is an osteogenic sarcoma or an endothelial myeloma, and (3) if a central sarcoma, whether it is a benign giant-cell tumor, a central malignant sarcoma, a multiple myeloma or a metastatic carcinoma. All the other histological sub-divisions are of little importance in deciding upon the method of treatment in a given case. The idea so widely prevalent that the large variety of neoplasms based upon histological distinctions represent an equally large number of separate diseases or entities is no longer tenable, at least, not in bone sarcoma. Berg,⁷ in his fellowship thesis, showed that by injecting the dried virus of the filterable fowl endothelioma tumor into the tibia of Rhode Island Red chicks it was possible to produce five different types of bone sarcoma, including endothelioma, corresponding almost exactly with the different types found in man. If it is possible, as Berg's work has proved, to produce in animals all these different varieties of bone sarcoma by a single extrinsic agent, we can no longer regard these different varieties as different diseases but as different manifestations of a single disease produced by a single agent. This does not necessarily mean that the same method of treatment should be used in these various types of tumors. We have found by experience that certain types of bone tumors (endothelial myeloma and giant cell) are highly sensitive to both irradiation and Coley's toxins, while, on the other hand, others, such as the osteogenic sarcoma with marked new bone formation, are very highly resistant to both. Hence it is important to know before we begin treatment just what type of tumor is present. We know that the tubercle bacillus does not give rise to lesions that are always typical, but that it causes a great variety of clinical manifestations, and that no one method of treatment is suitable for all of them.

While in the majority of cases we are able to make a correct diagnosis from the clinical and röntgenological evidence alone, there is a considerable number, probably from 20 to 25 per cent., in which a correct diagnosis is impossible without the aid of a histological examination. This brings up the question of indications and contra-indications of biopsy.

Biopsy.—The question of performing a biopsy in bone sarcoma for the purpose of establishing the diagnosis is one that is still unsettled. Some advocate a biopsy in every case as part of the treatment, while others, including Ewing, would omit the biopsy altogether or limit it to a very small number of cases. In my opinion the dangers and disadvantages associated with a biopsy have been greatly over-emphasized. The two most frequently mentioned are: (1) Dissemination of the tumor, by means of which some of the cells enter the circulation and cause metastases, and (2) failure of the biopsy wound to heal, resulting in infection, possibly necessitating an amputation.

If the biopsy is performed by the surgeon who is to have the final treatment of the case, one who employs the best operative technic, the danger of infection is extremely slight; furthermore, the possibility of generalization occurring by reason of the biopsy, in my opinion is also very slight, hardly sufficient to offer any serious objection to the operation. Dr. Francis Carter Wood, in his experiments on animal tumors, has shown that the danger of metastasis is not increased by the biopsy; and my experience with human beings supports this view.

As to the exact value of the biopsy, after it has been performed, there is also much difference of opinion. Pfahler and Parry⁸ believe that when the expert radiologist is in doubt, the pathologist is also often in doubt; and if the microscopical slides are sent to several equally expert pathologists, the opinions are apt to differ. Furthermore, he quotes Ewing as saying that the röntgenograms are of equal or greater importance than the microscopical section.* Kolodny often finds that with a good clinical history and röntgenograms, one can be as sure of a diagnosis as from seeing the patient, the lesion, the gross specimen and numerous sections, and adds, "Not infrequently a röntgenogram is more decisive than a number of microscopic sections." This opinion has been expressed by many of the leading pathologists as well as Ewing.

My personal opinion is that when trying to make a diagnosis of bone sarcoma, especially in the early stages of the disease, we should not trust to the röntgenogram alone unless the clinical evidence strongly supports it. It is most important that a correct diagnosis be made as early as possible if the treatment is going to be of any avail. While it is often possible in the later stages of the disease to make a positive diagnosis of osteogenic sarcoma from the röntgenogram alone, this is not true in the early stages. Therefore, in trying to make a diagnosis in the early stages, one should take advantage of all that is to be gained from a careful study of the clinical history, the physical examination and the röntgenogram. In a limited number of cases it will be necessary to make, in addition, a histological study of the gross specimen and microscopical sections removed at biopsy.

Two years ago† the opinion was published in the lay press that all that

* I believe that Ewing has usually qualified his statement by "sometimes."

† In connection with the Bone Sarcoma symposium at Baltimore, Md.

was needed to make a correct diagnosis of bone sarcoma was for the family physician to send a film of a suspected tumor to a radiologist and get his diagnosis by return mail. This idea gives a very erroneous impression of the many difficulties associated with the early diagnosis of bone sarcoma. The impracticable side of this plan is well illustrated by the following statement of Bloodgood:⁹

"A surgical colleague tells me that he has submitted the X-ray of a bone to sixteen consultants and got sixteen opinions. Another informs me that he submitted his case to eight authorities; all agreed on amputation without biopsy, and after amputation the lesion proved to be osteomyelitis of the Garre non-suppurative type."

It is only by a careful weighing of all the evidence including the clinical, röntgenological and pathological, that one is able to reach a correct diagnosis in many of the more difficult cases; and in a certain and fortunately very limited number of cases the most experienced observer will find it impossible to do so with the aids mentioned.

Frozen-section Diagnosis.—Many writers, including Bloodgood and Lewis, advocate making a diagnosis from frozen sections obtained at the biopsy; if the condition proves to be malignant, an amputation is at once performed; if the condition proves to be a benign giant-cell tumor, conservative treatment is employed. Personally, I do not believe that such an important matter as the amputation of a limb should be determined from a microscopical examination of frozen sections of a bone tumor. In many instances the specimen contains so much bone and cartilage that it is impossible to make sections without decalcification. In other cases in which the specimen contains soft tissue only, I find it frequently impossible to tell whether we are dealing with a benign condition or a malignant one. Therefore, I have given up trying to make a definite diagnosis from frozen sections. I believe it is perfectly safe to wait for the paraffin sections; I have seen no harm result from this delay.

A clinical history of rapid tumor growth accompanied by severe pain, even with a doubtful röntgenogram or no röntgenogram at all, may furnish sufficient grounds for an amputation. I have performed an amputation in a considerable number of cases of bone sarcoma without a biopsy, upon clinical and X-ray evidence alone, and in each case the condition has proved to be malignant.

Surgical Treatment.—The treatment of sarcoma of the long bones by amputation dates back to the time when this condition was first recognized as a malignant process, although classified under a great variety of names.

Unfortunately, in the earlier years, and, in fact, until recently, amputation was not performed until the disease had progressed so far that there was little or no hope of saving the patient's life by any method of treatment.

Not until 1920 did we begin to see marked improvement in the results of amputation alone for sarcoma of the long bones. In 1922, Meyerding¹⁰ reported a series of 100 cases treated by amputation; in many, prophylactic-toxin treatment was given, and in some this was supplemented by röntgen

therapy. At the time of the report, 50 per cent. of the patients were living, 16 per cent. over five years.

In May, 1923, at a symposium on Bone Sarcoma by the Association of Surgeons of Great Britain and Ireland, in London, Gask reported a series of fifty-seven cases of sarcoma of the long bones, exclusive of giant-cell tumors, admitted to St. Thomas's Hospital from 1901 to 1921. Out of forty-six cases in which amputation was performed, twelve were alive three years later, and seven more than five years later; one of these died of metastasis to the skull more than six years after amputation.

I believe the improvement in prognosis during the last decade is undoubtedly due to our ability to make an earlier diagnosis by reason of a more correct interpretation of the early röntgenograms and an early adoption of surgical measures (amputation). In our own series the prognosis has improved as a result of combining the systemic treatment with the toxins of erysipelas and *Bacillus prodigiosus* with surgical operation or irradiation.

Disarticulation.—I have performed hip-joint disarticulation for sarcoma in seventeen cases without mortality but with only two permanent recoveries. In one case the recovery was due not to the amputation alone but to the prophylactic-toxin treatment as well.

This patient, a young girl, was operated upon by Dr. William T. Bull, in 1893, for a periosteal fibrosarcoma of the metatarsal bone; an amputation above the ankle was performed. One and a half years later the disease recurred in the stump, and a metastatic tumor the size of a child's head appeared in the popliteal space. Under Coley's toxins the disease showed marked regression; but one year later it began to increase in size and I performed a hip-joint amputation. Within a short time extensive metastases developed in the gluteal region and the condition became quite inoperable. Under prolonged toxin treatment the disease steadily regressed until it had entirely disappeared. The patient is well at the present time, thirty-eight years since the treatment was first begun. In a second case of amputation at the hip by Dr. Stuart McGuire (1917), for round-cell sarcoma (endothelial myeloma) in a boy aged three and one-half years, the patient was referred to me for treatment of extensive, inoperable metastases to the skull (June, 1919); under toxin- and radium-treatment the tumors disappeared and the patient is in fine health today, thirteen years later.

During recent years I have performed very few disarticulations and these only in cases in which the disease occupied the middle and upper third of the femur. In nearly all the cases in which the disease occurred in the lower half of the femur I have found it possible to amputate below the trochanter leaving a sufficient stump to permit the use of an artificial leg. I believe if prophylactic-toxin treatment is given after such an amputation one will get practically as many permanent recoveries as if a disarticulation had been performed.

In performing an amputation without disarticulation, it is important that this should be done at a point at least four or five inches beyond the apparent extension of the tumor as shown by palpation and röntgen-ray. In a very large number of cases in which we have amputated below the trochanter for periosteal sarcoma of the lower portion of the femur, there has been a re-

currence in the stump in only four cases. In two cases of osteogenic sarcoma of the upper end of the humerus very satisfactory results were obtained by resection and irradiation; both patients are well over ten years.

My first successful result with the toxins in sarcoma of the long bones occurred in 1897, in a young man twenty-seven years of age with an extensive periosteal spindle-cell sarcoma of the tibia, in which the diagnosis had been confirmed by Dr. John Caven, Professor of Pathology of the University of Toronto. Many who had seen the patient before he came to me had advised an amputation. I decided to try the toxins alone.



FIG. 1.

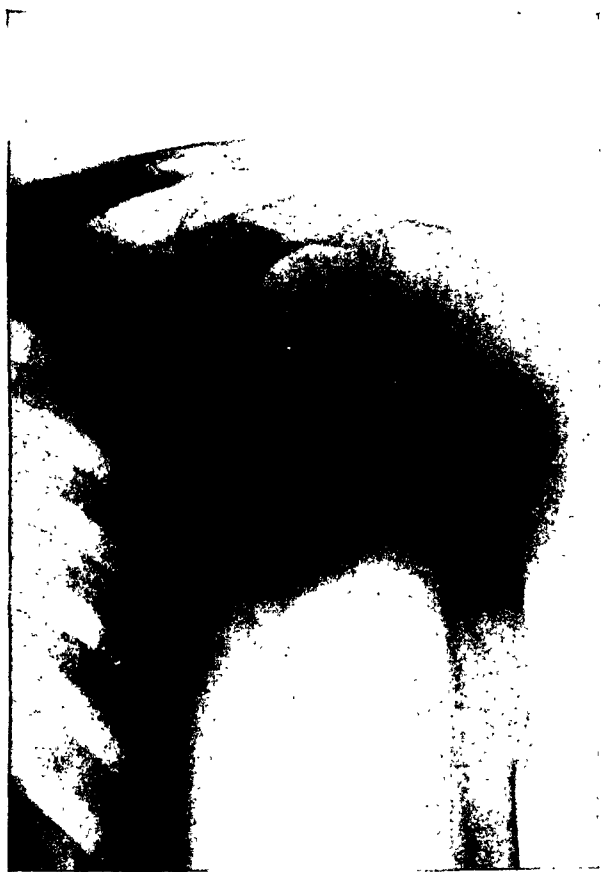


FIG. 2.

FIG. 1.—Spiral fracture of the shaft of the humerus (May, 1923), showing no evidence of a pathological condition at the time of injury.

FIG. 2.—Same case as shown in FIG. 1, this film having been made one year later showing a very extensive endothelial myeloma of the humerus at the site of the fracture. The condition was inoperable at the time of the author's first observation. The case was treated with toxins for two and a half years in addition to two radium-pack treatments. Good recovery was made, the patient being well eight and a half years later, with a useful arm.

Under two months' treatment, the tumor had almost entirely disappeared and the bone cavity had healed by healthy granulations. Just as he was about to be discharged, he contracted a severe attack of erysipelas which started at the site of an old sinus from a previous operation and extended over the entire leg and thigh. The patient made a complete recovery and was discharged from the hospital three weeks later. When last traced, thirty-two years later, he was still in excellent condition with a perfectly useful limb.

TREATMENT SARCOMA LONG BONES

I had continued to use conservative treatment (a brief course of Coley's toxins) before amputation in all cases of periosteal sarcoma. However, since 1920, I have come to realize that the osteogenic type, especially that associated with new bone formation, is highly resistant to toxins as well as to irradiation, and that immediate amputation followed by prophylactic toxin treatment offers the greatest hope of benefit.

After amputation or resection for osteogenic sarcoma, Fraser¹³ believes in exposing the skeletal outline, the lungs and the mediastinum, to intensive X-rays, concentrated if possible within twenty-four hours, using 250,000 volts and giving a 70 per cent. (sarcoma) dose. He states that this has been responsible, in two cases in which resection was performed, for the prolongation of life. He also maintains that Coley's toxins are of value in preventing or delaying metastases. He feels that the latter, in conjunction with resection, offers a field of possibilities as great if not greater than that of amputation.

Irradiation.—During the past ten years there has been an increasing tendency to refer all cases of bone sarcoma to the radiologist for treatment. The reason for this is obvious: Up to 1920 the results of amputation in malignant periosteal sarcoma were so bad that the surgeon, and, even more, the patient, were ready and willing to turn to any other method of treatment that offered any reasonable hope, especially if such method avoided the sacrifice of the limb. While irradiation was employed soon after the discovery of the röntgen-ray, it was not until the introduction of the high-voltage machine and the acquisition of large amounts of radium that the treatment of bone sarcoma by irradiation was carried out on a large scale.

The impression has been given by some writers, *i.e.*, Evans and Leucutia,¹⁴ that I am definitely opposed to irradiation for bone sarcoma. On the contrary, I was the first to employ X-rays in the treatment of bone sarcoma (in 1902 at the Memorial Hospital) and during the past fifteen years I have made an earnest effort to determine its value in the different types of bone sarcoma. Between 1915 and 1928, practically all the service cases, including those of giant-cell tumor, at the Memorial Hospital were treated by primary irradiation. Having a large amount of radium at our disposal, at first four grams, and later eight grams, a considerable number of cases were treated with the radium pack; this was sometimes supplemented by bare tubes of radon or gold seeds inserted into the tumor. The majority of cases, however, were treated with röntgen-rays by Doctors Herendeen and Duffy. It was hoped that in the event of failure to control the disease by irradiation, a later amputation after prolonged irradiation might yield better results than would an early amputation without pre-operative irradiation. Unfortunately, this hope proved unfounded. In 1928, a careful review of the results obtained in more than 140 cases of primary operable malignant sarcoma of the long bones treated by irradiation showed only four patients alive and well beyond the five-year period. Hence, we have abandoned irradiation as the primary method of treatment for osteogenic sarcoma, and have substituted immediate amputation followed by a course of prophylactic treatment with Coley's toxins.

At the International Cancer Congress in London, 1928, Ewing,¹⁵ who

had long been a strong advocate of primary irradiation for bone sarcoma of all types, gave his views as follows: "When the signs point to a true osteogenic sarcoma of medullary and sub-periosteal, sclerosing, or telangiectatic type, the best treatment is probably immediate amputation, preceded if necessary by a biopsy at the same time. With these cases, radiation seems to have accomplished very little."

On the other hand, we find Pfahler and Parry,¹⁶ in 1931, advocating irradiation for osteogenic sarcoma. However, their report of fifty-seven cases contains only six cases of sarcoma of the long bones well for a period of five years or more; four of these six cases were treated by amputation in addition to irradiation, and one by excision. The only one treated without surgery had no microscopical confirmation of the diagnosis. Therefore, the results in this series were not obtained by irradiation alone but by irradiation *plus surgery*. Had irradiation been continued for a longer period of time, as in the Memorial Hospital series and as is advocated by Holfelder, I am certain that the results reported by Pfahler and Parry would have been much less favorable. In the Memorial Hospital series, primary irradiation was given for a much longer period than one month, and amputation was performed only after failure to control the disease by irradiation; the number of five-year recoveries is exceedingly small, much smaller than in the group treated by primary amputation and prophylactic-toxin treatment.

Holfelder,¹⁷ the Director of the Röntgen Institute of the Surgical University Clinical, Frankfort, whose statistics are frequently quoted, especially by Pfahler, reports twenty-five cases of bone sarcoma treated with deep röntgen therapy during the years 1920-1921 and 1925-1926 (up to June 30). Sixteen of these cases were traced upwards of three years, and the remaining nine for more than two years. Of the sixteen cases, six are stated to have been clinically cured; three of these were under observation for more than five years. In only three of these six cases was the diagnosis verified by histological examination. In six other cases improvement was noted which lasted over a period of from one to two years. Ten patients died of the disease. Of the nine cases that were traced for upwards of two years, seven remained clinically cured at the time of the report; in six of these the diagnosis was confirmed by histological examination. It is important to note that nearly one-third of these cases were giant-cell tumors.

While Holfelder deems the number of cases reported and the period of observation insufficient to justify more definite conclusions as regards end-results, he believes they do warrant the conclusion that the clinical results of röntgen treatment of bone sarcoma, if properly conducted, will certainly not be worse than the best results obtained with radical operative procedures. He states that inasmuch as röntgen treatment of bone sarcomas completely avoids the serious mutilation of radical operation, he feels it a duty, even at this early date, to advocate conservative röntgen therapy for all types of bone sarcoma, in preference to any of the mutilating operations. He goes

TREATMENT SARCOMA LONG BONES

still farther than Pfahler and Parry in advocating prolonged irradiation, rather than amputation after a short period of irradiation.

However, I believe Holfelder's series of cases is far too limited in number, and the period of observation too short to influence one in substituting irradiation for amputation in the treatment of osteogenic sarcoma of the long bones.

According to Forssell,²² radiological treatment alone should not as yet be advised for operable cases of osteogenic sarcoma of the long bones. While pre-operative and post-operative irradiation should be used with conservative operation—this combined method has doubled the proportion of cures at the Radiumhemmet—he doubts whether irradiation prior to or after amputation is of any use. Yet "it may be worth while considering the possibility that a healing process initiated by radiation may in some cases bring about an increased resistance against tumor formation." He urges that tumor treatment, both surgical and radiological, be centralized in the largest hospitals, since special technic and training are so necessary. He estimated that in all the hospitals in Sweden only twenty malignant tumors of the long bones are admitted each year, hence the necessity of concentrating the material.

Undoubtedly, a very large number of osteogenic sarcomas have been treated in this country by primary irradiation during the past ten years, and the statistics of the Bone Sarcoma Registry of the American College of Surgeons should show a considerable number of five-year recoveries, had the method proved successful. As a matter of fact, however, the Registry shows only two cases of osteogenic sarcoma (one of the long bones) cured by irradiation alone; and in one of these cases the diagnosis was based on the clinical and röntgenological evidence alone, and in Doctor Ewing's opinion was by no means positive; he believed the condition simulated a myositis ossificans.

Preliminary Irradiation.—While Bloodgood believes that a brief trial of preliminary irradiation before biopsy entails no risk, personally I have seen several cases in which I believe harm has resulted from irradiating a long bone sarcoma for even a short period of time, *i.e.*, less than one month.

In spite of the improved results from early amputation, the fact remains that at the present time a very large number (in my opinion, the majority) of osteogenic sarcomas are being treated by primary irradiation as the method of choice—and this is true of some of the foremost hospitals of the country.

Treatment of Osteogenic Sarcoma.—In view of the fact that osteogenic sarcoma is highly resistant to both irradiation and Coley's toxins, I believe an amputation should be performed as soon as a positive diagnosis has been made. I do not approve of preliminary irradiation. Within one week of the operation the patient should receive prophylactic treatment with the mixed toxins of erysipelas and *Bacillus prodigiosus*. (Coley.) This treatment can be carried out at home later on by the local physician. The initial dose should be small, not over one-half minim, and gradually increased to the point of producing a moderate reaction, a temperature of 101° or 102°. The injections should be kept up, with occasional intervals of rest, for at least six months; they need not greatly interfere with the patient's routine of life. I believe that the prophylactic toxin-treatment more than doubles the number of five-year recoveries obtained by early amputation alone.

There is a certain type of osteogenic sarcoma now classified as periosteal fibrosarcoma which involves the periosteum alone or the muscular attachments of the periosteum, in which there is little or no bone involvement. This is more benign than the ordinary osteogenic sarcoma. In this type one is justified in trying to save the limb by conservative treatment (local irradiation and systemic toxins). We have under observation at present four cases in which the disease has been held apparently under complete control for three years. In addition there are a few cases of osteogenic sarcoma of the osteolytic type, highly cellular, with little or no new bone production, that have been cured by toxins alone or in conjunction with irradiation.

However, these apparent permanent recoveries under considerative treatment are limited to a certain rare type of osteogenic sarcoma. As a general rule, I believe that early amputation followed by a course of prophylactic treatment with Coley's toxins should be the method of choice in the treatment of osteogenic sarcoma of the long bones.

Endothelial Myeloma or Ewing's Sarcoma.—This type of tumor has been found to be much more amenable to treatment with toxins and radium than has the osteogenic type. It is a type with very definite clinical, röntgenographical and histological characteristics, different from those found in osteogenic sarcoma. As Ewing¹⁹ pointed out, it originates chiefly in the shaft of the long bones, and occurs mostly in children or young adults. The röntgenogram, together with the clinical history and physical signs, is usually sufficient to establish the diagnosis; but in the small group in which it is impossible to make a correct diagnosis, I believe one is justified in performing a biopsy. We have used the aspiration method of biopsy in this type with some success.

Treatment.—Surgery alone has given very poor results: only one case in twenty-two reported by Howard and Crile²⁰ was alive three years after amputation. I have never seen a case cured by amputation alone.

Some remarkable recoveries under toxins and irradiation combined are reported in my paper on Endothelial Myeloma, already referred to (1931). While a very considerable number of cases have been treated by primary irradiation alone (twenty-five cases in our own series), so far there has been only one five-year cure, but, unfortunately, in this case there was no microscopical examination to verify the diagnosis.

We are able to report but a very few cases treated by amputation after prolonged irradiation for the reason that while one is congratulating himself on the rapid diminution or complete disappearance of the primary tumor, metastases frequently develop, and it is then too late to amputate. We have, however, ten cases in which amputation was performed after prolonged irradiation. This group contains one five-year cure; no patient survived amputation much longer than one year. A review of the earlier statistics of Gross, and of the later statistics of Meyerding and others, shows but few cures from amputation alone in that group previously classified as small round-cell sarcoma but now known as endothelial myeloma or Ewing's sar-

coma. While we have been able to treat successfully a considerable number of cases of endothelial myeloma that were beyond amputation, and in some of which metastases had already developed, we must admit that we have not infrequently failed to control the disease even when the treatment (toxins and irradiation) was begun at an early stage. Thus it is difficult to decide on the best method of procedure in an early operable case of endothelial myeloma of a long bone. If we amputate at once, following this with prolonged prophylactic-toxin treatment, we may expect a permanent cure in about 50 per cent. of the cases. If we try to control the disease by local irradiation combined with systemic toxin treatment, we shall probably get a successful result in at least 30 per cent. of the cases. A certain number,

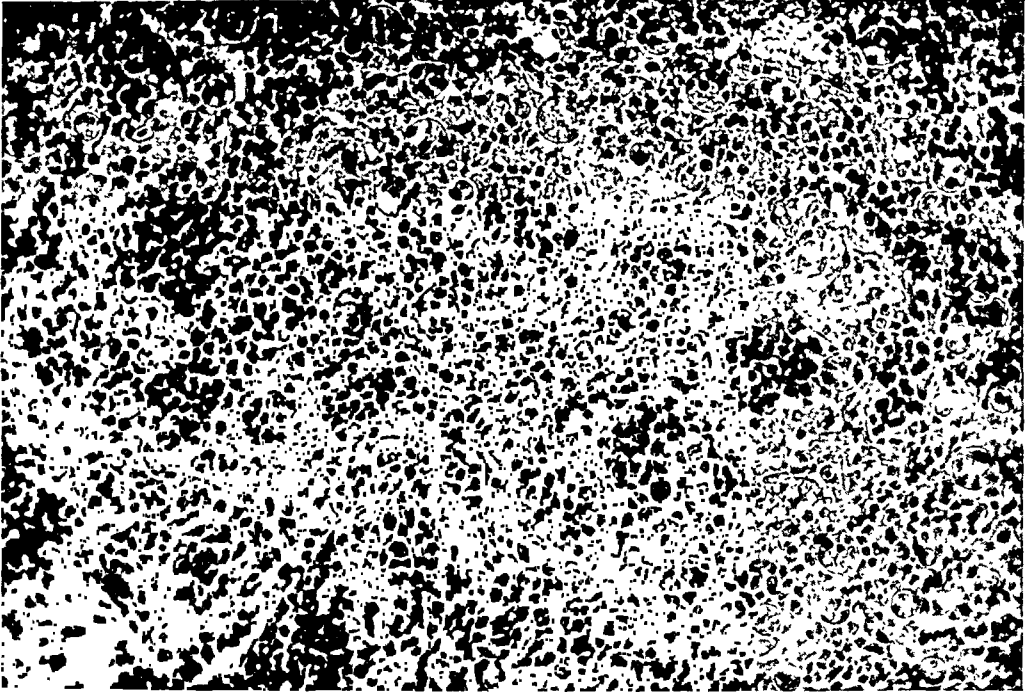


FIG. 3.—Microphotograph.

however, will develop metastases while undergoing treatment and even while the local condition is showing marked improvement; then amputation cannot be considered. In view of the complexity of the question of treatment, it is well when dealing with an adult patient to explain the matter as fully as possible and to let him have some voice in the decision.

A careful analysis of the end-results of different methods of treatment would seem to warrant the conclusion that while endothelial myeloma is the most malignant of all types of bone tumor, one is justified in trying systemic treatment with the toxins of erysipelas and *Bacillus prodigiosus* (Coley) combined with local irradiation, preferably the radium pack, for a limited period before resorting to amputation. If no marked improvement is noticed at the end of six or eight weeks, amputation or resection should be performed, followed by prolonged prophylactic-toxin treatment. Further delay without evidence of improvement may result in the development of metastases, with the loss of all hope of saving the life of the patient.

The most significant fact brought out by our statistics is the comparatively large number of inoperable cases that have recovered and remained well for five years or more. Fifteen cases of inoperable long-bone sarcoma were well more than five years; nine were treated by toxins, and six by toxins and radiation.

Multiple Myeloma.—This type of tumor has long been regarded as uniformly fatal, so much so that but scant reference to the subject of treatment is made in any of the literature. Geschickter and Copeland,²⁵ in their report of thirteen cases observed at Johns Hopkins, pass over the subject of treatment with the following brief statement:

With no proved case reported as cured it is evident that palliative symptomatic treatment only is available. Nursing care to avoid unnecessary pain on motion and pathologic fracture is important. When fractures occur, the ordinary methods of treatment by fixation may be given, as pain is thus minimized and healing often accomplished. Morphine for pain, liver diet and tonics for anæmia and inhalations for respiratory complications are helpful.

According to Ewing,²⁷ these cases invariably have a fatal termination. Meyerding²⁶ believes treatment is of little avail. He states: "Radiotherapy may produce temporary benefit; surgical treatment is of no value except as a diagnostic aid, and transfusions are of transient value."

In a recent paper on the subject, covering fifteen cases of multiple myeloma, I reported a case in which the disease involved the spine and ribs; there was partial paraplegia; the diagnosis had been confirmed by microscopical examination. Under Coley's toxins alone this patient made a complete recovery and remained well for five years, when he died of lobar pneumonia. In another case in which the disease involved the spine and ribs and was accompanied by complete paraplegia and loss of fifty pounds in weight, and in which irradiation had been tried without success, the patient made a good recovery under Coley's toxins. One year later, he was able to walk about with the aid of a cane, he had regained most of his lost weight, and röntgenograms of the skeletal bones showed no evidence of the disease. He was still in good health when traced, more than three years after the beginning of treatment; but I have learned recently that he has a recurrence.

Inasmuch as these tumors are radiosensitive and as most of the bones are involved, the Heublein unit established at the Memorial Hospital a year ago would seem to be the best method of administering the treatment. By this method the patient receives continuous irradiation all day, with the exception of short intervals for meals and medical visits, over a period of many days or until the desired erythemic dose has been received, depending on the indications in a given case. The usual period is from two to three weeks. One patient with multiple myeloma was treated in the Heublein unit of the Memorial Hospital about six months ago with very marked improvement. The Heublein method of irradiation, combined with systemic treatment with Coley's²⁸ toxins, seems far superior to any other for such a temporary condition.

TREATMENT SARCOMA LONG BONES

In view of the results obtained in our series, I have come to the conclusion that the prognosis in multiple myeloma is by no means as hopeless as is universally believed. In a number of cases the disease has been held in check for a considerable period of time by Coley's toxins alone and by irradiation alone; it is apparently susceptible to both agents; therefore I believe a combination of systemic toxins and local irradiation is the method of choice in the treatment of multiple myeloma; and no case should be given up as hopeless until this combined treatment has been given a thorough trial.

Giant-cell Tumors.—Curiously enough, there still remain the same doubt and uncertainty that existed seventy years ago, as to the true nature of the so-called benign giant-cell tumor. The theory that these tumors are always benign and never metastasize dates back to the first half of the nineteenth century (Lebert,³¹ Paget³⁰ and Nélaton³²). Virchow³³ (1862), however, contended that giant-cell tumors are sometimes malignant and give rise to metastases, and his opinion was strongly endorsed by Gross,³⁴ (1874). Some twenty-two years ago the whole question was revived by Bloodgood,³⁵ and it was largely due to his somewhat dogmatic and frequently reiterated statement that giant-cell tumors are always benign and never metastasize, that surgeons were led to abandon amputation as the primary method of treating giant-cell tumors, and to attempt to save the limb by curettage or irradiation. Irrespective of whether we agree with Bloodgood's views or not, we *must* admit that his teachings have had an important influence towards a more conservative treatment of these tumors, and that many limbs have been saved thereby. The view of the benignity of giant-cell tumors gradually gained adherents, and by 1924 it might be stated that the majority of pathologists all over the world had adopted it. In my³⁶ paper on the Prognosis in Giant-cell Sarcoma of the Long Bones, based on a study of fifty cases personally observed, I stated:

There is only one explanation of these cases which still leaves it possible for one to entertain the theory that giant-cell tumors are always benign; and that is to assume that all of the cases here reported, in which metastases developed ending in death, were cases of mistaken diagnosis. As a matter of fact, however, in the author's personal series of cases, the diagnosis of benign giant-cell sarcoma was made not only by competent pathologists, but in many cases by the very pathologists who had made a most careful study of bone tumors; so that if men of such wide experience are unable to differentiate the benign from the malignant type until death from metastases occurs, how much less likely is it that pathologists of ordinary experience will be able to make such differentiation.

Since the publication of that paper I have had an opportunity of studying forty-eight additional cases, making a total of ninety-eight cases of giant-cell tumor of the long bones observed at the Memorial Hospital and the Hospital for Ruptured and Crippled. In no less than fourteen cases the condition proved to be malignant; in four of these cases the early diagnosis of giant-cell sarcoma rested on clinical and röntgenological evidence alone; later, after prolonged irradiation, the diagnosis was confirmed by microscopical examination.

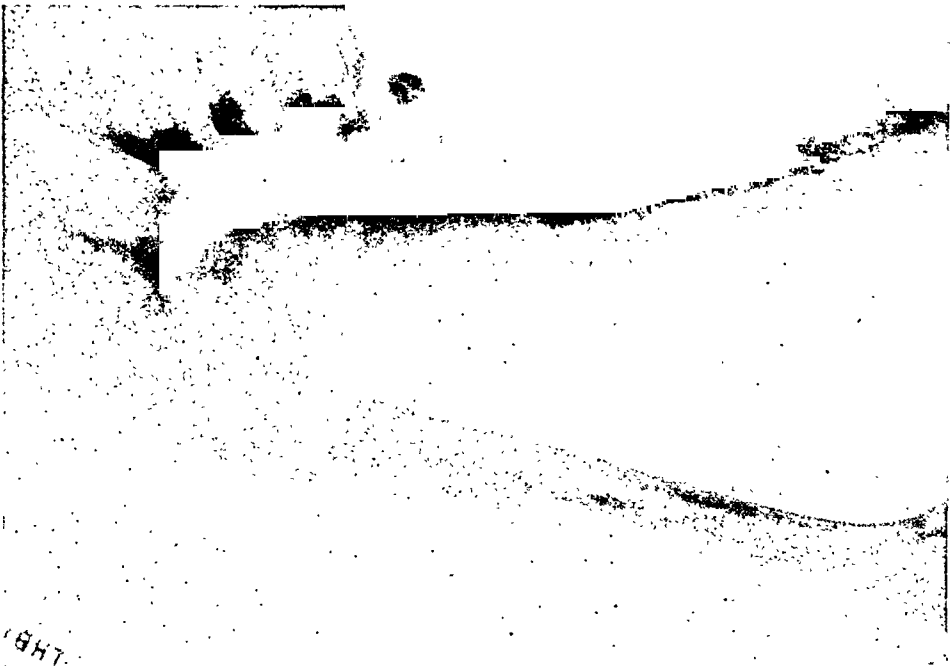


FIG. 4.

FIG. 4.—May, 1923. Giant-cell sarcoma of humerus. Toxins and radiation after exploratory operation. Patient well nine years later. Bone Sarcoma Registry at first classified this case as a malignant osteogenic sarcoma; later revised diagnosis.

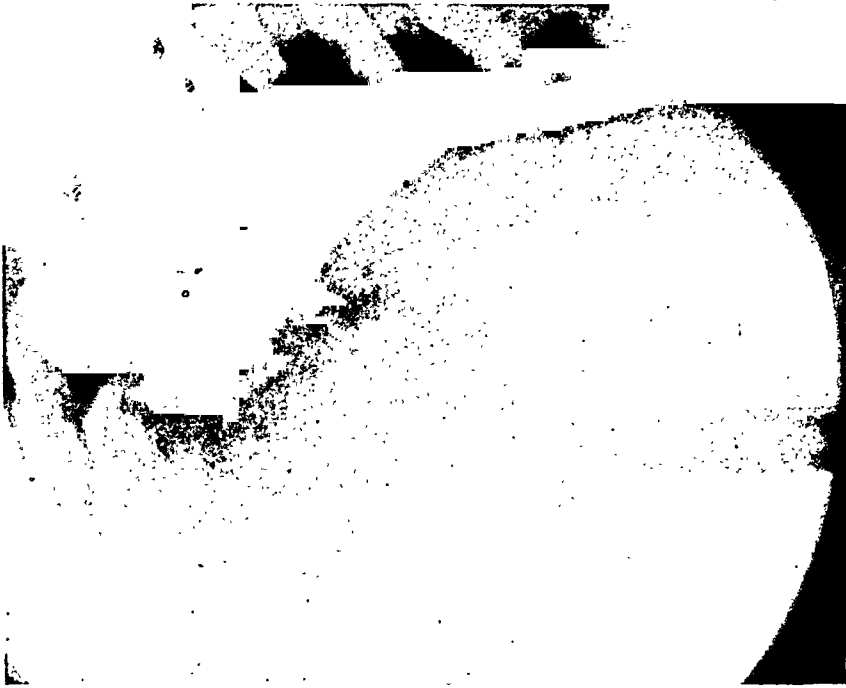


FIG. 5.

FIG. 5.—Same case six months later.

TREATMENT SARCOMA LONG BONES

A number of other surgeons have published cases of giant-cell tumor associated with metastases: Behring³⁷ collected 384 cases of sarcoma of the long bones operated upon in the leading hospitals of Sweden during the years 1901 to 1926. The diagnosis was verified histologically in all but two cases of a series of 246. Of this group, twenty-seven were classified as giant-cell sarcoma. All were operated upon more or less radically. In all of these cases the diagnosis of giant-cell sarcoma was made histologically by pathologists of large experience in the study of bone tumors. However, no less than

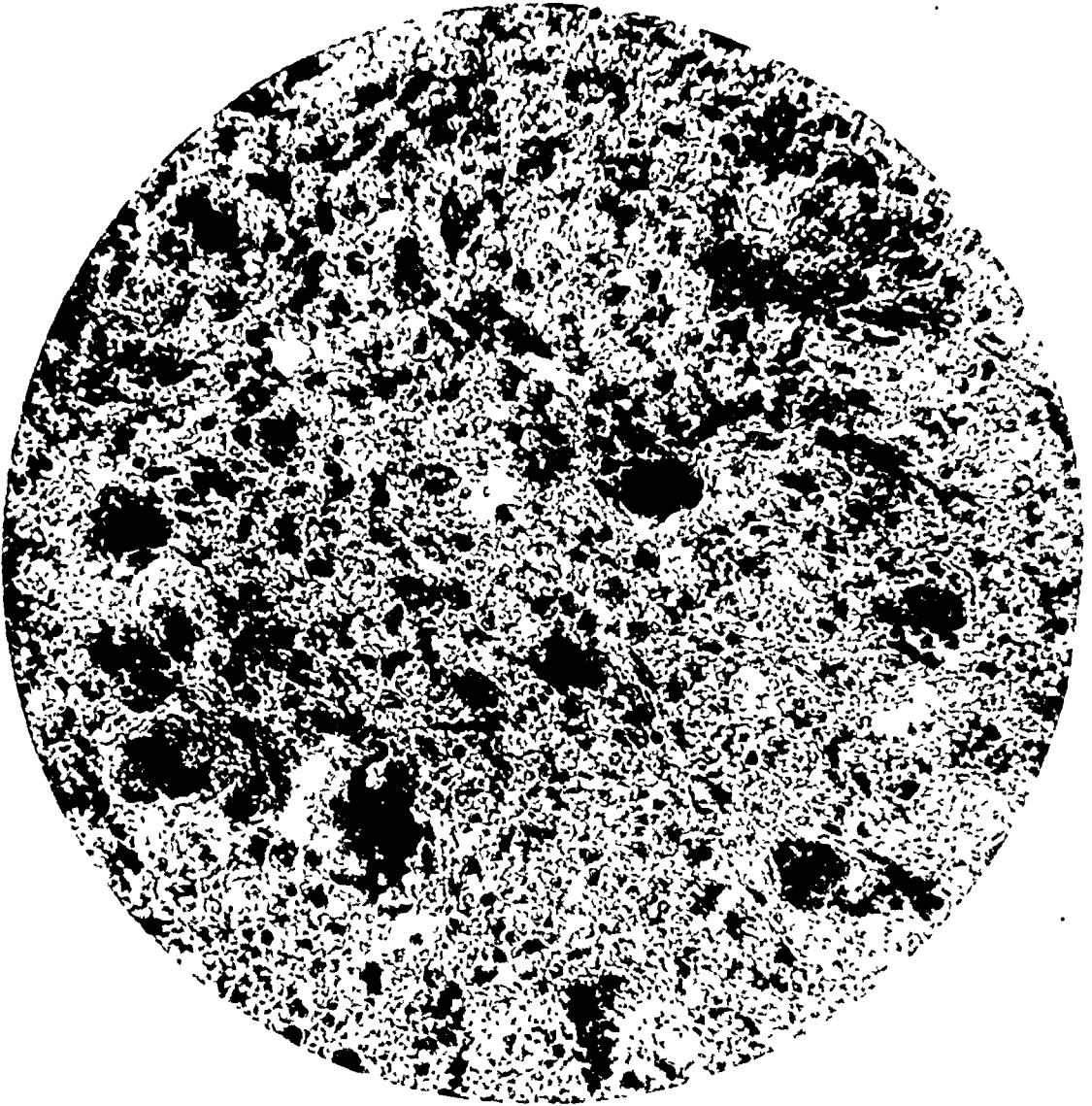


FIG. 6.—Microphotograph of same case as FIG. 4.

six of the twenty-seven patients died of metastases. Behring feels that the question of whether giant-cell tumors are always benign must be left open for the present.

Korchow,³⁸ of the State Institute of Radiology and Cancer Research, Leningrad, has made a study of fifteen cases of giant-cell tumors of bones observed during one year. It is interesting to note that in eleven cases trauma seemed to be an important etiological fact. While thirteen cases ran a benign course, two proved malignant. Eleven were treated by X-rays and four by operation. One was cured, two improved, nine unaffected, two became worse, and one died (but not as a result of the tumor). The author concludes that these tumors start as osteitis fibrosa but owing to trauma and other unfavorable factors the osteitis develops into a tumor which may become malignant. He

advocates biopsy for diagnosis and treatment. In most cases he believes that surgical treatment should be conservative (curettage, resection). According to Korchow, irradiation does not give very satisfactory results and is only specially indicated when operation is difficult or impracticable on account of the site of the tumor.

Simmons³⁰ states, in his review of the giant-cell tumors of bone collected by the Bone Sarcoma Registry prior to 1925 (116 in number), that he has seen four cases of giant-cell tumor in which death occurred from metastases; two were registered prior to 1925 and two since that date. Simmons adds that he knows of several other unpublished cases observed at other clinics, and that Codman also has seen several other cases.

These statistics and others would seem to force one to the conclusion that while the majority of giant-cell tumors are benign or only locally malignant, there is a very definite number which, while clinically and microscopically benign in the earlier stages, do later take on malignant characteristics and cause death by metastases. These cases, I believe, furnish conclusive proof that the view held by Virchow and Gross is more nearly correct than that of Nélaton. This does not mean that we as practical surgeons should move the clock backwards and again treat giant-cell tumors of the long bones by amputation as formerly. Experience has taught us that amputation as a primary method of treatment should seldom, if ever, be employed. Practically all these cases should be treated by conservative measures. I have not performed a primary amputation for a benign giant-cell tumor of a long bone for thirty years.

Treatment of Giant-cell Tumors.—The main objections to the surgical treatment of giant-cell tumors have been especially emphasized by Ewing and Herendeen. They are: First, the danger of serious hæmorrhages in the larger and more vascular giant-cell tumors; and second, the danger of infection either at the time of operation or later, due to failure to obtain primary union of the biopsy wound. It is asserted that if the larger cavities are packed with gauze they are apt to become infected sooner or later, while if an unhealed sinus persists, re-infection may occur, and amputation may become necessary.

Such is the picture often drawn illustrating the dangers of surgical treatment. There is no doubt that these dangers do exist and have been associated with the surgical treatment of giant-cell tumors in the past. The matter of chief practical importance is: are they seen frequently or but rarely, and are they associated with some failure in surgical technic? The critics of this treatment apparently think they are very common sequelæ. As a matter of fact, however, if curettage is performed with sufficient care and thoroughness, no packing is necessary; the wound can be entirely closed, and in nearly every case it will heal by primary union.

A careful analysis of more than 200 cases treated surgically at Johns Hopkins (100 by curettage) gives no support to the theory that infections with their attendant dangers are of frequent occurrence. In the entire series they were extremely rare and there were no deaths.

On the other hand, the bad results of irradiation in the treatment of giant-cell tumors are almost never mentioned, and from a study of the literature one might infer that they never occur. If we analyze the cases treated by this method at the Memorial Hospital, we find a considerable number of bad results that are quite as serious, if not more so, than those connected

TREATMENT SARCOMA LONG BONES

with surgical treatment. Among them may be mentioned that of pathological fracture. This not infrequently follows prolonged irradiation, especially in sarcoma of the femur. Of twenty cases of giant-cell tumor of the femur treated by irradiation at the Memorial Hospital, six developed a pathological fracture.

Then there is the danger of a late osteomyelitis developing after an apparent cure by irradiation. This has been observed in two cases under my own observation; in both an amputation was necessary. In addition there is the risk of radium burns which still occur occasionally even in the hands of experienced radiologists.

My chief objection to regarding irradiation as the method of choice in



FIG. 7.



FIG. 8.

FIG. 7.—Giant cell medullary sarcoma of lower end of femur, knee joint, and upper end of tibia. Treated with toxins and radium. Limb saved. Patient well eight years later when she died of hæmorrhages from childbirth.

FIG. 8.—Same case as FIG. 7, showing how Nature has reformed the destroyed condyle. Five years after treatment.

the treatment of giant-cell tumors of the long bones are: (1) The long period of disability, and (2) the impossibility of making a correct diagnosis of benign giant-cell tumor in at least one out of five cases from the clinical and röntgenological evidence alone.

Another advocate of irradiation for giant-cell tumors is Regaud,⁴⁰ but a glance at his statistics shows that of the fourteen cases reported, twelve occurred in the jaw (in these he had nearly 100 per cent. recoveries); one in the cervical spine, and only one in a long bone. This, unfortunately, was

treated primarily by resection and later by irradiation for a recurrence, so that Regaud's statistics offer practically no evidence of the value of irradiation in the treatment of giant-cell tumors of the long bones.

The prognosis in this group of tumors has been found to vary greatly with the particular bone affected, being graver when the disease is located in the lower end of the femur and the upper end of the tibia than when the radius, ulna or fibula is involved.

While our results at the Memorial Hospital have proven beyond a doubt that it is possible to cure a giant-cell tumor of a long bone, even of the femur or tibia, by irradiation, I do not think we have as yet proven this method to be superior to all others. There is still a grave objection to treating a supposed giant-cell tumor of a long bone by primary irradiation without a biopsy—as advocated by Ewing and Herendeen—for the reason that in at least one out of five cases it is impossible to make a correct diagnosis of benign giant-cell tumor from the clinical and röntgenological evidence alone. In other words, if we proceed in this manner we shall find that one out of every five cases will prove to be a malignant osteogenic sarcoma. By the time the error in diagnosis is discovered it is usually too late to save the life of the patient by amputation. Furthermore, the period of time required for this treatment in the majority of cases is too long to justify a general adoption of the method.

A simple biopsy should never be performed in a case of giant-cell tumor or one in which the clinical and röntgenological evidence points strongly towards a giant-cell tumor. If a giant-cell tumor, particularly of the long bones, is cut into at all, a thorough curettage down to healthy bone should be performed, the wound swabbed out with chloride of zinc or carbolic acid, and, if possible, closed without drainage. If this is done, then we have not performed a biopsy but have employed the surgical treatment, which, in my opinion, is the method of choice for giant-cell tumors. A simple biopsy is not advocated because of the difficulty of obtaining primary wound-healing, and the danger of sinus formation and infection owing to the high vascularity of these tumors.

During the last two years at the Memorial Hospital, in many cases of giant-cell tumor in which the bony shell* has been penetrated, we have found it possible to make an accurate diagnosis by the aspiration biopsy of Martin and Ellis⁴¹ or⁴² the Hoffman-punch biopsy. If a diagnosis can be made by the aspiration method without an incision, then my principal objection to the use of primary irradiation in the treatment of giant-cell tumors will have been overcome.

In many cases, however, it has been found necessary to introduce a large needle into a number of areas; and it is quite conceivable that in a highly vascular tumor some of the cells set free by the aspiration might enter the

* If the bony shell has not been destroyed it is impossible to use the aspiration biopsy method.

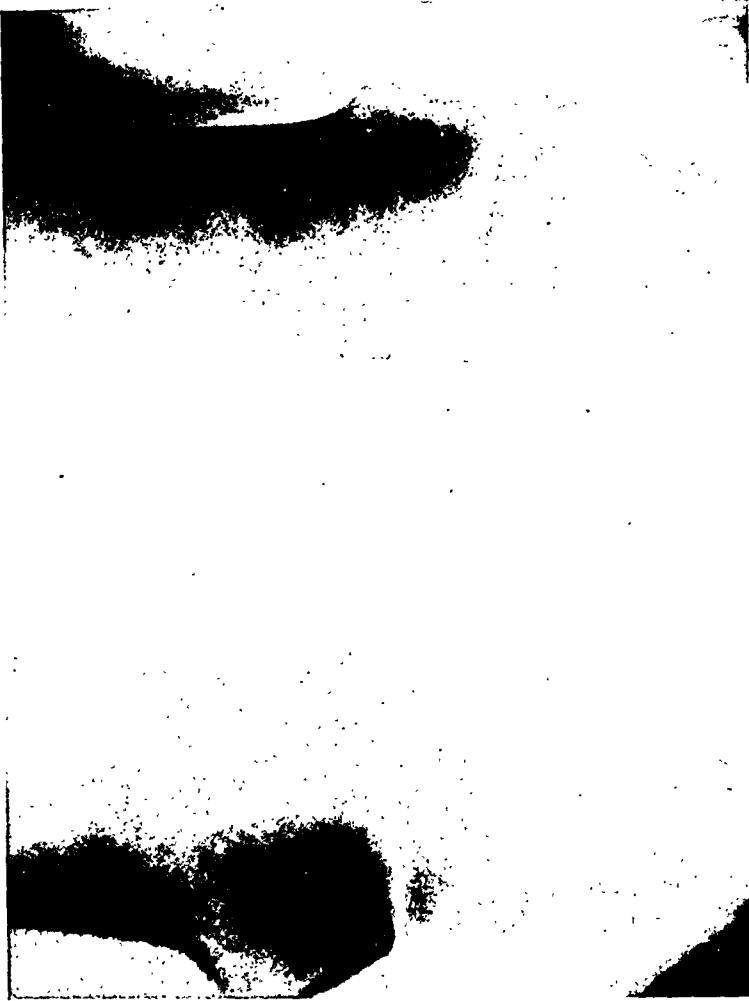


Fig. 9.

Fig. 9.—Giant- and spindle-cell sarcoma of femur with extensive involvement of entire knee-joint. Exploratory incision; toxins. Patient well fourteen years later. Picture shows Nature's attempt to form new condyle.



Fig. 10.

circulation and be carried to other parts of the body, thus giving rise to metastases. I am not at all sure but that this risk might be as great if not greater than any associated with a biopsy of the ordinary type. In one case, a large, highly vascular tumor of the ilium, the patient died suddenly of embolism on the day after an aspiration biopsy. It is possible that it was in no way connected with the biopsy.

If, on the other hand, the case is treated primarily by surgery combined with toxins or toxins and irradiation, the entire tumor will have been removed by curettage and the surgeon will have the benefit not only of a clinical, röntgenological and macroscopical examination, but of a careful histological examination as well. If the tumor proves to be a malignant central sarcoma,

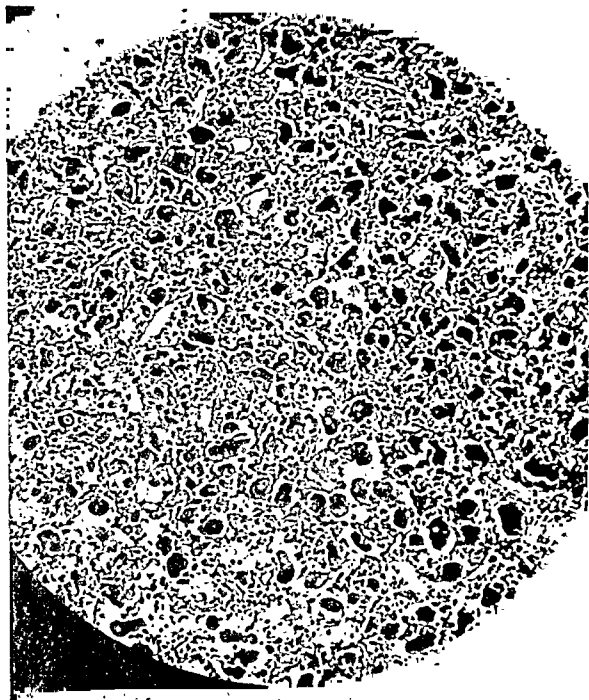


FIG. 11.

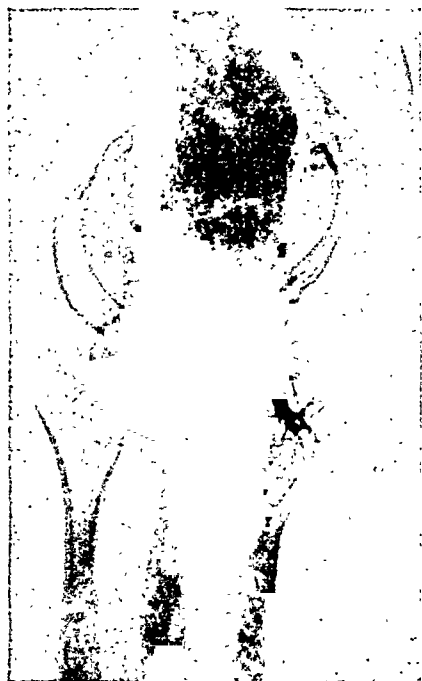


FIG. 12.

FIG. 11.—Malignant giant-cell sarcoma of mid-dorsal region. Microscopical diagnosis: round-cell sarcoma with many atypical giant cells. (Dr. Harlow Brooks.) Complete paralysis of bladder, rectum and lower extremities. Under four months' toxin treatment, patient made a complete recovery and is well thirty years later.

FIG. 12.—Giant- and spindle-cell sarcoma of tibia with destruction of upper four inches, treated by curettage, toxins and radium. Limb saved; patient well eighteen years later. Picture shows replacement of new bone five years later. Well seventeen years later.

immediate amputation should be performed followed by a course of prophylactic-toxin treatment. This method offers a much greater chance of saving the life of the patient. If the tumor proves to be a benign giant-cell sarcoma, the curettage and toxin treatment will, in my opinion, effect a complete recovery in the great majority of cases and in a shorter period of time than is required by irradiation.

Summary of Results.—In view of Bloodgood's repeated statement that the Johns Hopkins series prior to 1913 contains no case of bone sarcoma that has remained well for a period of five years, following any method of

treatment, I should like to call attention to the fact that our earlier series treated prior to 1913 contains nineteen cases of bone sarcoma of verified diagnosis that have remained well for from five to thirty-eight years. Nine of these cases were classified as endothelioma or small round-cell sarcoma, and ten as osteogenic sarcoma.

To this group we might add one other case of malignant giant-cell tumor of the spine associated with complete paraplegia and loss of fifty pounds in weight, treated in 1902 with Coley's toxins alone. (Fig. 13.) This patient was in excellent health with perfect function when I last examined him in July, 1932, thirty years after treatment.

In my⁴³ paper of 1913 I gave a tabulated report of 125 cases of sarcoma successfully treated with the toxins by other men. In this group were thirty cases of bone sarcoma that had remained well for five years or more; sixteen were inoperable sarcomas of the flat bones (diagnosis confirmed microscopically in eleven cases) and fourteen sarcomas of the long bones: six osteogenic sarcoma, five endothelioma, one giant-cell tumor, and no microscopical examination in two cases.

*Results in 168 Cases of Primary Operable Osteogenic Sarcoma of the
Long Bones Treated by Irradiation*

| Method | Cases |
|--|-------|
| Röntgen-ray..... | 84 |
| Röntgen-ray and radium..... | 10 |
| Radium (element pack in 30 cases)..... | 35 |
| Irradiation and Coley's toxins..... | 39 |
| | — |
| | 168 |

Of the eighty-four cases treated by röntgen-ray, the only five-year cures occurred in two cases in which amputation was performed after irradiation, and in one case treated by resection followed by irradiation.

Of the ten cases treated by röntgen-ray and radium, five-year cures occurred in two cases in which amputation was performed after irradiation.

Of the thirty-five cases treated by radium alone, the only five-year cure occurred in one case in which amputation was performed after irradiation, and in one case treated by resection and irradiation.

In other words, of 129 cases of osteogenic sarcoma treated by irradiation, there were no five-year cures obtained without amputation or resection. The percentage five-year cures in this group was 5.42 or seven cases.

Of the thirty-nine cases treated by irradiation and Coley's toxins, there were two five-year cures obtained without amputation, and two with amputation. Three other cases in which the limb was saved have remained well from two to four and one-half years. One of the five-year cures without amputation was a very extensive tumor of the humerus treated with irradiation and toxins over a period of one year. While the Bone Sarcoma Registry committee at first classified it as an osteogenic sarcoma, five years later they revised their diagnosis to that of giant-cell tumor. Excluding this case we have three five-year cures in a group of thirty-nine cases (7.9 per cent.).

Of the total number of 168 cases of operable osteogenic sarcoma of the long bones treated by primary irradiation, nine, or 6.4 per cent., were well for five years or more.*

While the results obtained by irradiation and Coley's toxins (7.9 per cent. five-year cures) are a little better than those obtained by irradiation without toxins (5.42 per cent. five-year cures) they are no better if as good as the results obtained by early amputation alone without pre-operative irradiation. This proves that osteogenic sarcoma is highly resistant to both irradiation and toxins and that we are no longer justified in substituting either for early amputation. The only two cases in the entire series of 168 operable osteogenic sarcoma in which the limb was saved were two in which the toxins were used in conjunction with irradiation.

Results in 72 Cases of Endothelial Myeloma of the Long Bones

| Treatment | Cases | Five-year Recoveries |
|---|-------|------------------------|
| Amputation alone..... | 2 | 0, or 0 per cent. |
| Coley's toxins..... | 9 | 6, or 66.66 per cent. |
| Coley's toxins plus amputation or resection.... | 14 | 9, or 64.3 per cent. |
| Irradiation..... | 25 | 1, or 4 per cent. |
| Toxins and irradiation..... | 22 | 6, or 27.27 per cent. |
| Totals..... | 72 | 22, or 30.55 per cent. |

NOTE.—Of forty-five cases in which the toxins were used either alone or in conjunction with surgery or irradiation, twenty-one, or 46.6 per cent., have remained well for five years.

Results in 217 Cases of Malignant Tumor of the Long Bones in which Amputation Was Employed

| Treatment | Cases | Five-year Recoveries |
|---|-------|-----------------------|
| Amputation alone..... | 15 | 0 |
| Amputation and Coley's toxins..... | 81 | 24, or 29.6 per cent. |
| Amputation after prolonged irradiation without toxins..... | 98 | 5, or 5.1 per cent. |
| Amputation after prolonged irradiation with Coley's toxins..... | 23 | 2, or 8.7 per cent. |

Of the latter two five-year recoveries, one was a periosteal fibrosarcoma of the tibia.

Femur Cases.—In making a comparative study of early and late statistics, it will be found that the most notable improvement in results are in sarcoma of the femur. While Butlin was able to find only one three-year recovery in a group of sixty-eight cases of sarcoma of the femur treated by disarticulation or amputation below the trochanter, our series of over 100 cases of sarcoma of the femur shows twenty-one five-year recoveries (twelve osteogenic and eleven endothelial myeloma). Of the eleven endothelial myelomas, no less than seven were inoperable and three had extensive metastases at the beginning of treatment; the limb was saved in seven cases. The treatment employed in these cases was as follows:

* In 10 of these cases the X-ray treatment had been carried out at other hospitals before the patients came under my observation.

TREATMENT SARCOMA LONG BONES

| | Five-year Recoveries | Per Cent. |
|---|-------------------------|-----------|
| Amputation alone in 10 cases..... | 0 | 0 |
| Amputation followed by Coley's toxins in 42 cases... | 12 | 28.57 |
| Amputation after prolonged irradiation in 48 cases... | 3 | 6.3 |
| Toxins and irradiation..... | 3 | |
| Toxins alone..... | 3 | |
| | — | |
| Total..... | 21 | |

As to giant-cell tumors of the femur, our results at the Memorial Hospital would seem to lend some support to the view of Phemister (quoted by Pfahler) that these cases should not be treated primarily by irradiation. We have seventeen cases of giant-cell tumor of the femur that were treated by primary irradiation; nine went on to amputation, and four died. Two other cases, after amputation, proved to be malignant osteogenic sarcomas, but these are too recent to mention the end-result.

Results in 98 Cases of Giant-cell Tumor of the Long Bones

| | Cases |
|--|-------|
| <i>Treated by Coley's toxins, with or without surgery.....</i> | 21 |
| Proved to be malignant osteogenic sarcoma..... | 2 |
| Primary amputation (one by another surgeon)..... | 2 |
| Secondary amputation..... | 5 |
| Well five years or more..... | 12 |
| Dead (osteogenic sarcoma)..... | 2 |
| <i>Treated by toxins and irradiation.....</i> | 16 |
| Proved to be malignant osteogenic sarcoma..... | 2 |
| Amputation..... | 9 |
| Well five years or more..... | 9 |
| Dead..... | 2 |
| <i>Treated by irradiation without biopsy or operation.....</i> | 31 |
| Proved to be malignant osteogenic sarcoma..... | 6 |
| Amputation..... | 8 |
| Well five years or more..... | 11 |
| Dead..... | 5 |
| Died of another cause..... | 1 |
| <i>Treated by irradiation after biopsy or curettage.....</i> | 17 |
| Proved to be malignant osteogenic sarcoma..... | 2 |
| Later amputation..... | 7 |
| Well five years or more..... | 6 |
| Dead..... | 4 |
| <i>Treated by surgery alone.....</i> | 13 |
| Proved to be malignant osteogenic sarcoma..... | 2 |
| Primary amputation (two by other men)..... | 4 |
| Resection..... | 3 |
| Secondary amputation..... | 3 |
| Well five years or more..... | 2 |
| Dead..... | 2 |

It should be noted that in the thirty-one cases of benign giant-cell tumor treated by irradiation without a biopsy, six proved to be malignant osteogenic

sarcoma; all dead. In the entire group of ninety-eight cases there were fifteen deaths.

Five-year Recoveries.—Of a total of 261 cases of malignant sarcoma of the long bones, exclusive of giant-cell tumors, treated prior to November, 1927, or five years ago, fifty-four, or 20.7 per cent. have remained well for five years or more. Twenty-two were classified as endothelial myeloma, and twenty-two as osteogenic sarcoma. Coley's toxins were used in forty-four of these five-year recoveries. Fifteen cases were either inoperable when the treatment was begun or became inoperable during the course of treatment.

Limb saved.—Of these fifty-four five-year recoveries, the limb was saved in twenty-one cases (twelve endothelial myeloma and nine osteogenic sarcoma). In all but two cases the diagnosis was confirmed by microscopical examination, but in these two there was a rapidly growing, extensive tumor of the femur involving the upper half of the shaft, beyond hip-joint amputation. One patient recovered under toxins alone and was well ten years later when last traced, and the other had toxins and one radium-pack treatment, and is well fifteen and one-half years later.

Conclusions.—I believe that a study of the results obtained in this series of 360 cases of malignant operable sarcoma (exclusive of 98 giant-cell tumors and nearly 100 inoperable cases) will prove that the present pessimistic attitude regarding the prognosis is without foundation in fact. The prognosis depends largely upon an early diagnosis and a wise choice of treatment.

For osteogenic sarcoma, especially the type associated with marked new bone formation, I advise immediate amputation as soon as the diagnosis has been established. In order to lessen the chances of a recurrence, Coley's toxins should be given as a prophylactic, for a period of six months.

While endothelial myeloma is highly sensitive to both toxins and irradiation, rarely has the disease been controlled by irradiation alone. On the other hand, the toxins alone or toxins combined with irradiation have resulted in a large number of five-year recoveries even, in some instances, after the disease had reached the inoperable stage and had developed metastases. I believe that a combination of the systemic effect of Coley's toxins plus the local effect of irradiation offers the greatest hope of saving the patient's life as well as his limb in this type of tumor. Early amputation followed by prolonged toxin treatment would undoubtedly give a higher percentage of five-year recoveries, and for this reason it is well to let the patient have a voice in the final decision as to the method to be employed.

I still believe that the most efficient method of treating giant-cell tumors of the long bones is: Early and thorough curettage, swabbing out the cavity with 50 per cent. chloride of zinc or carbolic acid and alcohol, closing the wound without drainage, and then on the third or fourth post-operative day starting a short course (four weeks) of prophylactic-toxin treatment to be given in moderate doses. Primary amputation or resection should practically never be performed in this type of tumor. Our series contains many cases

in which large areas of bone-destruction were completely restored by Nature, showing that resection and bone-grafting are unnecessary.

The series of cases reported in this paper differs from all others in two important points: (1) It includes a large number of inoperable, hopeless cases that have recovered under treatment and have remained well for more than five years, and (2) it contains a large number (19) of permanent recoveries that have taken place prior to 1913. The only possible explanation of these results is, that in the majority of cases Coley's toxins either alone or in conjunction with some other method were used.

In closing I wish to express my great appreciation to the following: to Dr. James Ewing and Dr. Frederick W. Stewart, for their kindness in examining most of the microscopical sections in this series of cases; to Dr. Ralph Herendeen and Dr. James J. Duffy, for their skilful treatment of the cases in which irradiation was employed; and to Dr. Bradley L. Coley, who has been associated with me for the past ten years in the Department of Bone Sarcoma at the Memorial Hospital and the Hospital for Ruptured and Crippled and who has performed the majority of amputations during this period.

Bone sarcoma is a field in which a careful weighing of all evidence, the clinical, the röntgenological and the histological, is required. In other words, in order to arrive at a correct diagnosis, especially in the early stages of the disease, a close coöperation on the part of the surgeon, the röntgenologist and the pathologist is most essential.

BIBLIOGRAPHY

- ¹ Kolodny, A.: Bone Sarcoma. Surg., Gynec., and Obst., vol. xliv, No. 4, A, Part II, p. 107, April, 1927.
- ² Crile, G. W.: Treatment of Malignancy. ANNALS OF SURGERY, vol. xciii, No. 1, p. 108, January, 1931.
- ³ Nové-Josserand, G., and Tavernier, L.: Tumeurs Malignes des Os. Gaston Doin & Cie, Paris, 1927.
- ⁴ Tavernier, L.: Le traitement radiothérapique des osteosarcomes. Le Cancer, Bruxelles, t. VI, No. 3, pp. 113-133, 1929.
- ⁵ Sabrazes, J., Jeanneney, G., and Mathey-Cornat, R.: Les Tumeurs des os. Masson et cie, Paris, 1932.
- ⁶ Geschickter, C. F., and Copeland, M. M.: Tumors of Bone. Am. Jour. Cancer, New York, 1931.
- ⁷ Berg, R. F.: The Experimental Production of Several Different Varieties of Bone Sarcoma. Am. Jour. Surg., New Series, vol. xv, No. 3, pp. 441-461.
- ⁸ Pfahler, G. E., and Parry, L. D.: Treatment of Osteogenic Sarcoma by Means of Irradiation. Am. Jour. of Roentgenol. and Radiol. Therapy, vol. xxv, No. 6, p. 761, June, 1931.
- ⁹ Bloodgood: Bone Tumors by Geschickter and Copeland, Chapter on Treatment.
- ¹⁰ Meyerding, H. W.: Surg., Gynec., and Obst., vol. xliv, Part 2, 1927.
- ¹¹ McArthur, L. L.: Chicago Med. Recorder, p. 120, 1895.
- ¹² Owens, J. E.: New Orleans Med. and Surg. Jour., July, 1897.
- ¹³ Fraser, J.: Tumors of Bones. Edinburgh Med. Jour., vol. xxxvii, p. 153, October, 1930.
- ¹⁴ Evans, and Leucutia: Am. Jour. Röntgenol. and Radium Therapy, vol. xx, No. 4, October, 1929.

- ¹⁵ Ewing, J.: The Classification and Treatment of Bone Sarcoma. Internat'l Cancer Congress, London, 1928.
- ¹⁶ Pfahler, G. F., and Parry, L. D.: Treatment of Osteogenic Sarcoma by Means of Irradiation, with a Report of Fifty-seven Cases. Am. Jour. Röntgenol. and Radium Therapy, vol. xxv, No. 6, June, 1931.
- ¹⁷ Holfelder, Hans: Unsere Erfahrungen über 25 Fälle von Knochensarkomen, welche mit Roentgentiefentherapie behandelt worden sind. Strahlentherapie, vol. xxxi, p. 33, 1928-1929.
- ¹⁸ Forssell, G.: Tumours of the Long Tubular Bones. Acta chir. Scandinav., vol. lxvi, p. 397, 1930.
- ¹⁹ Ewing, J.: A Review and Classification of Bone Sarcomas. Arch. Surg., vol. iv, No. 3, p. 485, 1922.
- ²⁰ Howard, W. T., and Crile, G. W.: ANNALS OF SURGERY, vol. xlii, p. 358, September, 1905.
- ²¹ Coley, W. B.: Endothelioma or Ewing's Sarcoma. Radiology, vol. xvi, p. 627, May, 1931.
- ²² Connor, C. L.: Arch. Surg., vol. xii, p. 789, April, 1926.
- ²³ Christian, S. L., and Palmer, L. A.: Military Surgeon, vol. lxi, p. 42, July, 1927; also Am. Jour. Surg., vol. iv, p. 188, February, 1928.
- ²⁴ Lilienthal, H.: Mediastinal Sarcoma—Treated by Coley's Fluid. ANNALS OF SURGERY, p. 615, April, 1927.
- ²⁵ Geschickter, C. F., and Copeland, M. M.: Multiple Myeloma. Arch. Surg., vol. xvi, No. 4, April, 1928.
- ²⁶ Meyerding, J. W.: Multiple Myeloma. Radiology, vol. v, No. 2, p. 132, August, 1925.
- ²⁷ Ewing: Jour. Neoplastic Diseases, third edition, p. 321, W. B. Saunders Co., 1928.
- ²⁸ Coley, W. B.: Multiple Myeloma. ANNALS OF SURGERY, vol. xciii, No. 1, p. 489, January, 1931.
- ²⁹ Geschickter, C. F.: ANNALS OF SURGERY, vol. xcii, p. 425, 1930.
- ³⁰ Paget, Sir James: Lecture on Surgical Pathology, No. 28, Part 1, p. 446.
- ³¹ Lebert: Physiologie patholog., vol. ii, p. 120, D. Balliere, 1845.
- ³² Nélaton: Étude sur une nouvelle espèce de tumeur bénigne des os, ou tumeur à myéloplaxes. Thèse de Paris, 1860.
- ³³ Virchow: Die krankhaften Geschwülste. Thirty Lectures, vol. ii, p. 1862-1863.
- ³⁴ Gross: Sarcoma of the Long Bones. Am. Jour. Med. Sci., 1879.
- ³⁵ Bloodgood, J. C.: Bone Cysts, Osteitis Fibrosa, Giant-cell Tumors, Bone Aneurism. ANNALS OF SURGERY, August, 1910.
- ³⁶ Coley, W. B.: Prognosis in Giant-cell Sarcoma of the Long Bones. ANNALS OF SURGERY, March and April, 1924.
- ³⁷ Behring, L.: Contribution to the Question of Growths of the Long Tubular Bones, Their Diagnosis and Treatment. Acta chir. Scandinav., vol. lxvi, p. 387, 1930.
- ³⁸ Korchow, W. J., Über die Riesenzellengeschwülste der Knochen. Zentrabl. f. chir., vol. lviii, pp. 2694-2701, 1931.
- ³⁹ Simmons, C. C.: Malignant Changes Occurring in Benign Giant-cell Tumors of Bone. Cancer Comm. Harvard University, reprint No. 283. Surg. Gynec. and Obst., vol. liii, pp. 469-478, October, 1931.
- ⁴⁰ Regaud, C.: Paris Médical, t. 51, No. 5, pp. 119-125, February, 1924.
- ⁴¹ Martin, H. E. and Ellis, E. B.: Biopsy by Needle Puncture and Aspiration. ANNALS OF SURGERY, vol. xcii, pp. 169-181, 1930.
- ⁴² Coley, B. L., Sharp, G. S., and Ellis, E. B.: Diagnosis of Bone Tumors by Aspiration. Am. Jour. of Surg., vol. xiii, No. 2, pp. 215-224, August, 1931.
- ⁴³ Coley, W. B.: The Treatment of Malignant Inoperable Tumors with the Mixed Toxins of Erysipelas and *Bacillus prodigiosus*. Trans. Third Internat'l Conference Cancer Research, Brussels, 1913.

TRANSACTIONS

OF THE

PHILADELPHIA ACADEMY OF SURGERY

STATED MEETING HELD MAY 2, 1932

The President DR. JOHN SPEESE, in the Chair

CALVIN M. SMYTH, JR., M.D., Recorder

LUMBAR SYMPATHECTOMY IN BUERGER'S DISEASE

DR. FREDERICK A. BOTHE presented a man, thirty-one years of age, who was admitted to the Presbyterian Hospital November 2, 1926, in the service of Dr. John Speese, on account of pain in both feet. He first experienced pain in the feet three months prior to admission. It was burning in character and he expressed it as feeling like "hot coals"; it was followed by a blanching of the skin and later the appearance of a purplish-red color, more pronounced in the toes. The pain would last from two to thirty minutes and then subside. These symptoms gradually became more severe and the week before admission to the hospital he suffered almost constantly. The pain was so severe at night that he was unable to sleep. He suffered more with the left than the right foot. Both second toes and the right great toe gave him the most constant severe pain.

Physical examination was essentially negative, except for the lower extremities. Both feet were perceptibly colder than the other parts of the body. When the feet were elevated there was definite blanching of all the toes and to a lesser degree the blanching extended up over the dorsum of both feet. When the legs were subsequently lowered, a deep purplish-red color replaced the blanched areas. All toes of both feet were involved. There was a large purplish spot about the size of the palm of one's hand on the dorsum of the left foot which persisted. A similar change occurred on the right foot but to a lesser degree. The pulsation of the dorsalis pedis artery was not palpable on the left foot and that of the posterior tibial was very faint. On the right foot both the dorsalis pedis and the posterior tibial pulsations could be felt but they were impaired.

A diagnosis of Raynaud's disease was made, and November 3, 1926, a left lumbar ganglionectomy was performed excising from the second to the fourth lumbar ganglion inclusive, and a peri-arterial sympathectomy for a distance of four centimetres was done on the left common iliac artery. Only one side was done at this time, the side which was giving him the most symptoms. Immediately after the operation his left foot felt warm and definite relief was obtained from suffering in this extremity, although it did not entirely disappear. Comparatively speaking, after the first operation he suffered less with his left leg than with his right leg. November 13, 1926, a similar procedure was done on the right side. Two months after the original operation, the second toe on his left foot had to be amputated, because of gangrene which would not clear up following the sympathectomy. One year after operation, the patient was readmitted as the symptoms had become progressively worse in his right foot, and gangrene had developed. The entire foot was a dusky red and cyanotic, and there was a sinus between the great toe and second toe. The second toe was gangrenous and no dorsalis pedis pulsation could be palpated. At this time he had little or no suffering in his left foot. A peri-arterial sympathectomy was performed on the right femoral artery, and at the same time the second toe on the right foot was amputated. The peri-arterial sympathectomy

gave no relief, so the right femoral artery was ligated and cut as advocated by Lewis. This gave no beneficial results. By this time the pain was unbearable and the gangrenous process had begun to involve the dorsum of the foot so the right leg was amputated below the knee.

The pathological report of the blood-vessels of the amputated leg was: first, dorsalis pedis shows proliferation of connective tissue with round-cell infiltration in all coats. The lumen is obliterated by an organizing thrombus. The posterior tibial artery shows the same microscopical findings in the wall and there were necrotic areas in the intima. *Diagnosis*.—Thrombo-angiitis obliterans.

The healing power was poor and reamputation was necessary above the knee before a satisfactory stump could be obtained. Following amputation intravenous injections of typhoid vaccine were started. These were given once a week for six weeks and then omitted for six weeks. This schedule was followed for this form of therapy. Twenty-five million organisms were used in the first injection and this number had to be increased to 200,000,000 before a reaction was obtained. This dosage was employed throughout the remainder of the protein therapy.

At the present time, five and a half years after his operation, he has a little soreness in his left foot which he expressed as being negligible. There is no blanching of the skin of the foot or toes when the foot is elevated and the purplish-red discoloration does not appear when the foot is lowered.

DR. FRANCIS C. GRANT said that at the University Hospital, there had been eight cases of Buerger's disease under his care. The results had been satisfactory with lumbar sympathectomy in all of them. One case was that of a thirty-five-year-old colored man who had a gangrene of the great toe of the right foot, with intense pain. The gangrene was sharply demarcated about the base of the toe. There were no arterial pulsations to be felt in either of the arteries of the foot. The femoral artery could be palpated but the popliteal could not. There was no sign of sugar in the urine and no evidence of arteriosclerosis. Blood sugar was normal. A right lumbar sympathectomy was done and his toe was amputated at the same time. At the time of the amputation, there was no bleeding and the chances for healing of the wound seemed to be very poor. He was kept in bed for six weeks, with the foot elevated and light treatment given over the wound. At the end of that time definite granulation tissue was appearing although a mild infection hampered repair. At the end of three months, the foot was entirely healed. The pain was relieved promptly following operation and has never returned. At the present time, two years following operation, the patient has had perfect healing without further trouble and no pain, and is able to be about wearing the shoes to which he is normally accustomed.

In cases of this type, where hitherto amputation would have been done, it seems justifiable to try the effects of lumbar sympathectomy first. By this procedure a number of limbs may be preserved.

DR. GEORGE P. MULLER remarked that he had twice exposed the lumbar sympathetics by an extraperitoneal approach. Beginning as a muscle-splitting (McBurney) exposure the peritoneum is swept off the fascia and muscles, past the ureter to the great vessels. It is quite simple to do in a thin person.

LUMBAR SYMPATHECTOMY IN BUERGER'S DISEASE



FIG. 1.—Film after injection of brominol.



FIG. 2.—Diagram of operative findings. Inset shows location of sinus.

PHILADELPHIA ACADEMY OF SURGERY

EXTERNAL PERFORATION OF THE GALL-BLADDER

DR. GEORGE P. MULLER reported the case of a white woman, aged forty-five years, who was admitted to Service B of the University of Pennsylvania Hospital October 25, 1931, complaining of a draining sinus in the right flank.

Eleven years before admission she began to suffer from attacks of upper right quadrant pain. These attacks were severe, the onset usually sudden, duration variable, and the pain radiated to the back. The attacks were always associated with nausea, vomiting and constipation. There was no history of jaundice, pruritus, or clay-colored stools. The attacks became progressively more severe. In December of 1923 she was admitted to Lankenau Hospital, Philadelphia, during an attack which had existed for two weeks. The pain in this latter attack was atypical; it was lower than usual and more to the right.

Physical examination at that time revealed a smooth mass extending well to the lateral side of the right abdomen, down to the iliac spine, and lateral to the gall-bladder area. The mass did not move with respiration and was not tender. Blood sugar and urea were normal, urinalyses negative and blood count as follows: hæmoglobin, 80 per cent.; red blood-cells, 3,240,000; white blood-cells, 8,400, with normal differential. X-ray of the abdomen (flat plate) showed no evidence of biliary or renal calculi. The right kidney was negative to cystoscopical examination and pyelogram.

At operation, performed by Dr. John B. Deaver, January 4, 1924, a large "growth" was found involving the ascending colon, judged inoperable, and a lateral anastomosis was carried out between the terminal ileum and the transverse colon.

When the patient recovered she was referred to the Oncologic Hospital for radium treatment. Here ten days after admission she developed a large abscess in the right flank. After incision at first only pus exuded, but later the sinus began to discharge small gall-stones. She remained at the Oncologic Hospital six months, receiving three radium treatments over the tumor mass, since this perforation was thought to be due to breaking down of a carcinoma.

From this time on the sinus continued to drain pus and discharge stones, until when admitted to the University Hospital, she exhibited a four-ounce bottle nearly filled with small, faceted, black stones. Local pain occurred with the passage of each stone, followed by relief and improvement in general well-being. Bile never appeared in the drainage.

The patient's status on admission to Service B was essentially the same as described. Her sinus still drained, she had occasional upper right quadrant and epigastric pain, but felt well in general and had been consistently gaining in weight.

A barium enema showed a functioning ileocolostomy, and a suspicious area about three inches distal to the hepatic flexure, although there was no evidence of obstruction.

A cholecystogram was done, and when the gall-bladder showed no shadow in the first film, twenty cubic centimetres of bromidized oil were injected into the sinus. This was observed to pass around a large object, on beyond and into the duodenum. The film (Fig. 1) taken immediately thereafter showed the true state of affairs—namely, a gall-bladder located far more laterally and lower than normal, its cystic duct going upward beneath the common duct to open into it near the duodenum. Defects in the gall-bladder to which the sinus directly led suggested the presence of stone. The cystic duct was plainly visible as a corrugated shadow in the lumen of the larger common duct.

Operation was performed October 31, 1931, under gas and ether anæsthesia. A catheter was first inserted into the sinus, methylene blue was injected, and the catheter left in place. A vertical incision was then made medial to the scar of the previous operation. Adhesions were resected. The ileocolostomy was found to be in good order. A mass was found underneath the liver (Fig. 2), extending against and adherent to the lateral abdominal wall just above the hepatic flexure of the colon. Methylene blue shining through showed this mass to be connected with the sinus. It was dissected

UROGENITAL CYST OF THE MESOSIGMOID

free from the liver above and the colon below. It contained one large gall-stone and several small stones. The gall-bladder was removed with the exception of a small piece of the neck which could not be dissected free. This portion was closed. The fundus of the gall-bladder was found connected with the sinus, and after removal of two stones in this portion, the catheter previously inserted was identified. The wound was then closed with two drains, repairing the incisional hernia by application of fascia.

The patient reacted well to the operation. There was considerable drainage through the old sinus. The anterior drains were removed, and the wound healed normally. The small catheter was kept in the sinus for four weeks, during which time three more stones were discharged. At present the sinus has been healed for three months. Pathological section showed the tissue removed to be gall-bladder surrounded by inflammatory tissue.

External perforation of the gall-bladder is very rare. Gariepy, in 1929, reviewed

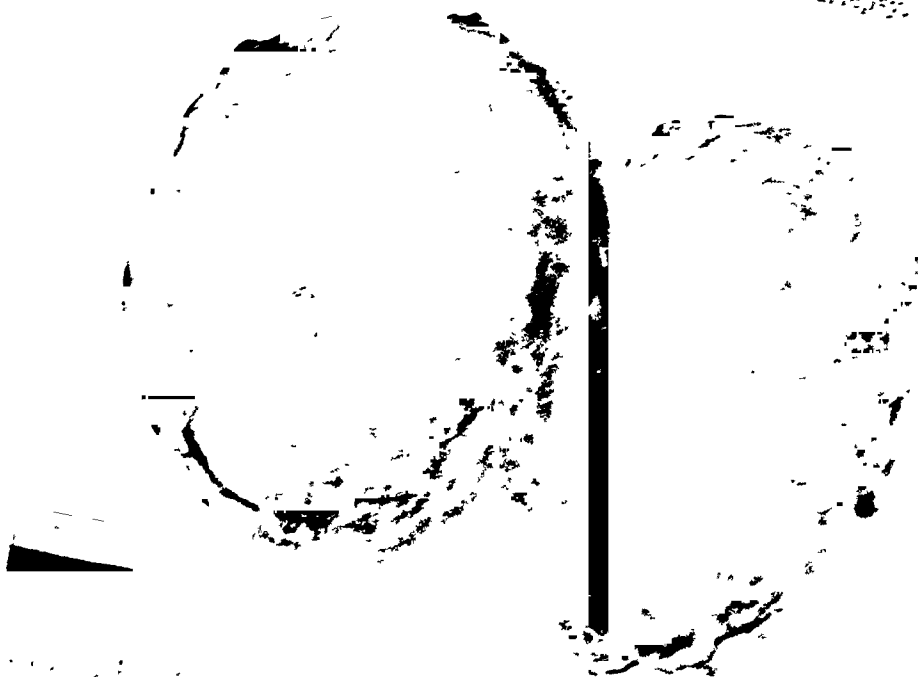


FIG. 2.—Urogenital cyst, gross appearance. (Lent.)

the literature and found only three recorded cases in modern literature. He reported one case of rupture through the anterior abdominal wall, and cited Hoerhammer's case which did the same. Bege reported a case of rupture through the right flank, similar to the present case, and Abell reported another with rupture below Poupart's ligament. Courvoisier, in 1899, reported 196 cases of external perforation, but was himself doubtful of the veracity of the records. Since Gariepy's report McCay has discussed another case in which perforation occurred through the left lumbar region. He also made use of injection of iodized oil to make his diagnosis. He was unable to find a record of a single similar case.

UROGENITAL CYST OF THE MESOSIGMOID

DR. WILLIAM E. LEE reported the case of an adult Negro female, forty-seven years of age, who was admitted December 7, 1931, to the B surgical service of the Pennsylvania Hospital, complaining of a dull aching sensation in her lower left abdominal quadrant. She stated that she had been perfectly well until November, 1931. At this time she noticed, when standing for long periods of time, a dull aching pain in her

lower left quadrant. This would frequently be relieved by assuming the lying or sitting position. During the previous two months she was more constipated and would often resort to laxatives. While her appetite had always been good she now frequently eructated large amounts of gas. Within four weeks the pain became so severe that she sought admission to the hospital. The only other positive symptomatology was nocturia three or four times nightly. This was not accompanied by urgency nor burning. She had noticed this especially during the previous three months. At no time had she complained of any severe, sudden, or sharp abdominal pain. Nor had she at any time had any nausea or vomiting.

She was a well-nourished sthenic Negress, in no apparent distress. The physical examination was essentially negative except for the abdomen in which cavity there was a palpable mass the size of an orange in the left lower quadrant, not attached to the skin and quite readily movable. There was slight tenderness on deep pressure but no rigidity. Neither liver nor spleen was palpable.



FIG. 4.—Urogenital cyst, microscopical appearance. (Lee.)

A second mass could be felt by bi-manual examination, in the left lower quadrant, indefinite in outline. The adnexa were not palpable.

At operation, December 22, 1931, by Doctor Lee, the omentum was found to be adherent to a mass in the left lower quadrant, after this was dissected free there was observed in the mesocolon, proximal to the sigmoid, a large cystic mass. (Fig. 3.) This mass extended into the pelvis, the lower border being in the hollow of the sacrum. It measured ten by eight by five centimetres. This cystic mass was enucleated without rupturing or injuring the mesenteric vessels, and the mesocolon repaired, no damage having been done to the blood supply. The abdomen was closed without drainage.

The patient's convalescence was uncomplicated and she left the hospital January 14, 1932. She has been seen in the "follow-up" clinic since, and reports being free of symptoms at the present time.

The cyst on being opened showed a thin septum dividing it into two lobules, which contained a clear pseudomucilaginous fluid. Sections taken through the cyst-wall at

UROGENITAL CYST OF THE MESOSIGMOID

various points show microscopically a thin fibrous tissue wall lined with a low, compressed, darkly stained epithelial cell layer. (Fig. 4.) In one place there is a small polyp formation with stroma of connective tissue and epithelial cells resembling those of the Fallopian tube. The pathological diagnosis is a Wolffian duct cyst.

The reporter added to his report of this case the statement that mesenteric cysts, both on account of their rarity and questionable etiology, deserve to be reported. A careful search of the literature shows that three hundred and twenty-nine have been published to date.

It seems most probable that this case may be classified under those of urogenital origin. These form by far the smallest group of peritoneal or mesenteric cysts. Niosi, in 1907, collected five cases. Since that time only twenty-five have been added. The majority of the reported mesenteric cysts have been of the chylous group, and of these the greatest number have been in children. This case is one of the few of the adult cases that have been reported.

Ewing says, when writing of intraperitoneal cysts of urogenital origin: "These cysts are of large size, single, or multilocular, involving mesentery or adjacent regions, or extending into the pelvis, and occur chiefly in adult women. The contents are usually a brownish serous fluid, containing pseudo-mucin. The wall is composed of fibrous tissue and the lining is of high cylindrical or cuboidal glandular epithelium, which may be deficient in some areas."

The origin of these cysts presents a difficult problem, but it seems probable that they are derived from aberrant remnants of the Wolffian body and that the embryonic disturbance occurs at various periods in the history of this structure.

Incidence.—Most of the reported cases have been in children, although the condition itself may be found at any age. Cases have been reported in foeti and Moynihan⁵ reports one in the eightieth year. The incidence in females is greater than in males about two to one.

Pathological Anatomy.—The cysts are usually rounded but may be spherical or lobulated. They vary in size from that of a split pea to one sufficiently large to contain 8.2 litres as reported by Fehleisen.⁶ The walls are often very thin, and smooth unless they are adherent to surrounding structures, but cysts have been reported that have had walls as thick as one centimetre.

For the most part mesenteric cysts are located in the vicinity of the terminal ileum and jejunum. Only about 10 per cent. of the reported cases have been located in the mesocolon.

The contents vary in color, consistency and specific gravity. The majority contain material of a chylous nature.

Symptomatology and Diagnosis.—There are no pathognomonic symptoms nor signs which make for the diagnosis of mesenteric cysts. So infrequently is this diagnosis made pre-operatively that Atchley⁷ writes, in 1929: "The diagnosis of mesenteric cysts has, in a very few cases, if ever, been cor-

rectly made pre-operatively." This same statement was made by H. C. Deaver in 1909, and by C. P. G. Wakeley⁸ in his report of a case of mesenteric cyst in an eight-day-old infant in 1932.

The symptoms are due for the most part to the size of the tumor and its encroachment upon the lumen of the intestine. If the growth is a rapid one the symptoms are acute. Hence acute intestinal obstruction with all its symptoms and signs develop. If a slow growth, then there are likewise the symptoms and signs of a chronic partial intestinal obstruction. The latter is especially true when middle-aged adults are the patients.

Of symptoms, *pain* in all its degrees seems to be the most common. This may be very acute or occur as a dull aching sensation lasting over a long period of time. It may be associated with nausea, and later vomiting, depending upon the pressure on the abdominal viscera, blood-vessels and nerves. Again, gaseous eructations are frequently encountered. Constipation, either alone or with alternating periods of diarrhœa, is often complained of by the patient; relief, if a slow-growing cyst, may be brought about by changes in posture. Moynihan emphasizes a rapid and serious wasting as a prevalent sign of this condition but the majority of writers have failed to confirm this.

Physical examination offers the most aid. The presence of an abdominal tumor, usually in the lower quadrants, should bring the possibility of a mesenteric cyst to the examiner's mind. Moynihan and Shands speak of lateral mobility as a striking feature. This, of course, will depend upon the size of the cyst and whether or not it has become adherent to surrounding structures. Tympany has been found over the tumor in close proximity to dull areas. This is due to the empty intestine above the cyst.

Small cysts, of course, give no suggestive signs but may give rise to all the signs and symptoms of an "acute" abdomen.

The presence of the following symptoms or signs in one degree or another should bring to the physician's mind the possibility of a mesenteric cyst.

(1) Palpable tumor in the lower abdomen which is only moderately painful. (2) Constipation either alone or with alternating periods of diarrhœa. (3) Various degrees of indigestion, from mild gaseous eructations to severe nausea and vomiting with all the signs of acute intestinal obstruction. (4) A normal blood-picture unless dehydration and serious vomiting are present. (5) X-ray of the gastro-intestinal tract showing abnormal position of the intestine or some encroachment upon the lumen of the bowel. (6) Tympanitic areas in close proximity to dull areas.

The conditions which often simulate mesenteric cysts and must be differentiated are: (1) Intussusception. (2) Ectopic pregnancy. (3) Ovarian cysts. (4) Volvulus. (5) Malignant cysts. (6) Tuberculous cysts, especially in children. (7) Retroperitoneal growths. (8) Hydronephrosis. (9) Movable kidney. (10) Pancreatic cysts. (11) Cysts of the urachus. (12) Lipoma of the mesentery. (13) Pregnancy. (14) Internal hernia, in babies. (15) Acute abdominal conditions when cysts are small.

UROGENITAL CYST OF THE MESOSIGMOID

Complications.—(1) In over 50 per cent. of cases intestinal obstruction has complicated mesenteric cysts. (2) Intussusception from hyperperistalsis. (3) Peritonitis. (4) Hæmorrhage into the cyst. (5) Torsion of cyst with volvulus. (6) Rupture of cyst either into bowel or into peritoneal space. (Timbal.⁹) (7) Dilatation of stomach. (Atchley.) (8) Impaction in pelvis.

Prognosis and Treatment.—The reported cases give a mortality of about 35 per cent. Uncomplicated cases should recover following operations. In the event that resection of the bowel is necessary, the risk of course increases.

The *treatment* is primarily surgical. The most promising of all procedures is enucleation. Swartley,¹⁰ in 1927, reported this having been done in ten of sixteen cases without a death. To this we add one more. Drainage alone is frequently all that is possible, especially in patients unable to stand a longer or more tedious operative procedure or when the cyst has become bound down by multiple adhesions. This procedure is apt to leave a draining sinus and enucleation must be done eventually. Coley¹¹ estimates the mortality of all classes of cysts drained to be about 6 per cent.

Resection of the bowel has the highest mortality of all the surgical procedures attempted. Miller reports three deaths in five cases, or 60 per cent. mortality. In these cases the high mortality was no doubt due to the critical condition of the patient.

Marsupialization has been performed successfully in a few cases. Along with aspiration it is now obsolete.

Conclusions.—(1) Mesenteric cysts are still of such rarity that they should be reported. (2) The case presented is of the rarer urogenital variety and adds another bit of evidence that such cysts are embryonic in origin. (3) Although the diagnosis is still difficult, the condition should always be considered in the diagnosis of the surgical abdomen. (4) The treatment of choice is enucleation.

BIBLIOGRAPHY

¹ Ewing, James: *Neoplastic Diseases*, 1922.

² Dowd, C. N.: *ANNALS OF SURGERY*, vol. xxxii, p. 515, 1900.

³ Niosi, Francesco: *Virchow's Archives*, vol. cxc, pp. 217-338, 1907.

⁴ Miller, R. T.: *Bulletin Johns Hopkins Hospital*, vol. xxiv, p. 316, 1913.

⁵ Moynihan: *Medical Chronicle*, September, 1902.

⁶ Deaver, H. C.: *Congenital Mesenteric Cysts*. *ANNALS OF SURGERY*, vol. xlix, pp. 618-627.

⁷ Atchley, R. Q.: *Journal of the Oklahoma Medical Association*, vol. xxii, pp. 125-129, 1929.

⁸ Wakeley, C. P. G.: *British Journal of Surgery*, vol. xix, pp. 511-512, 1932.

⁹ Timbal, R.: *Revue de Chir.*, vol. xii, pp. 45-227, 1910.

¹⁰ Swartley, W. B.: *Mesenteric Cysts*. *ANNALS OF SURGERY*, vol. lxxxv, pp. 846-886, 1928.

¹¹ Coley, W. B.: *ANNALS OF SURGERY*, vol. i, p. 512, 1910.

¹² Elkin, B.: *Mesosigmoidal Cyst Taken for Ovarian Cyst*. *Bull. d'obst. et de Gynec.*, vol. xvii, p. 341, March, 1928.

THE EFFECT OF BLOOD IN EXPERIMENTAL PERITONITIS

DR. LEE RADEMAKER (by invitation) read a paper with the above title for which see page 414.

DR. GEORGE P. MULLER said that this study represents an enormous amount of work, and shows the importance of rigid control. Last Fall, Doctor Rademaker finished a series of experiments in which he brought out an idea regarding the causation of intra-abdominal adhesions and showed very definitely that infection of the abdominal wall would produce them. In their clinical records, they found seven operated on for adhesions and six of the seven had infected abdominal walls. This contribution of Doctor Rademaker's rather negatives the impression which most have that blood in the abdominal cavity is productive of adhesions or that this blood might favor infection in the peritoneal cavity. Apparently, he has shown in his study that blood does not favor infection, but, on the contrary, tends to minimize it. This may explain why the mortality of operation for ectopic pregnancy is so low. If the hæmorrhage is controlled, these patients get well and rarely come back complaining of severe abdominal adhesions.

RECURRING EXTERNAL DISLOCATIONS OF THE PATELLA

DR. B. FRANKLIN BUZBY read a paper with the above title for which see page 387.

BILATERAL AVULSION OF THE LESSER TROCHANTER OF THE FEMUR

DR. DFOREST P. WILLARD and DR. JESSE T. NICHOLSON (by invitation) presented a colored boy, aged twelve years, who gave a history, beginning December 13, 1930, of pain in his *right* thigh in the region of Scarpa's triangle without previous injury or accident. He was not handicapped in walking. December 18, 1930, he slipped on some ice and fell with the leg extended, landing on the right side. He was forced to walk with a limp after this. That night the pain became severe and the leg stiff. The following day he was carried into the accident ward. A posterior dislocation of the hip was diagnosed by the interne. The leg was manipulated and a "snap" suggestive of reduction obtained. Function immediately appeared normal. The röntgenological check-up, however, revealed a separation of the epiphysis of the lesser trochanter. He was placed in bed with sandbags along the side of the leg, and a few days later a plaster spica was applied to hold the right thigh in partial flexion, slight internal rotation and mild adduction. He was discharged on crutches the following day (December 24, 1930). He failed to return to the clinic until April 6, 1931, at which time the plaster bandage was removed. Hip motion was free and painless. July 31, 1931, both hips were equal in range of motion.

October 10, 1931, he fell, catching himself on his *left* knee with immediate pain in left groin. This persisted and was accentuated by motion. Two days later (October 12) he walked into the clinic favoring the left leg. The thigh was held in 15° flexion, 5° adduction, but not rotated. Passive motion was possible from 170° to 90°, abduction 5°, adduction 20°, internal rotation 65°, and external rotation 0°. There was tenderness on deep pressure in Scarpa's triangle. The right hip was normal. Separation of the lesser trochanter of the left femur was verified by X-ray. A short plaster spica, holding the thigh in 90° flexion, 5° adduction and 5° internal rotation was applied. After six weeks this bandage was removed and the leg brought down to 165° and another bandage applied for two weeks. January, 1932, there was full return of power and motion.

MULTIPLE TRAUMATIC BURSITIS

The reporter added that while the literature revealed many cases of avulsion of the lesser trochanter of the femur, there was no record of a bilateral involvement. The earliest case was accredited to Morgagni, Moreau, and Lecouturier. Previous to the advent of röntgenology (1908) but ten cases were diagnosed.

MULTIPLE TRAUMATIC BURSITIS

DR. DEFOREST P. WILLARD, and, by invitation, DR. JESSE T. NICHOLSON presented a colored man, fifty years of age, who had sustained an injury to his left knee. He bled profusely. Upon examination he was found to have a tumor growth (sixteen centimetres in length, ten centimetres in thickness and 8.5 centimetres in width) on the anterior surface of the left knee (Fig. 5.) The overlying skin was scaly, indurated and adherent. The mass was hard and firm with small flocculent areas. At its lower border were three ulcerated areas; the largest, two centimetres in diameter, was bleeding pro-

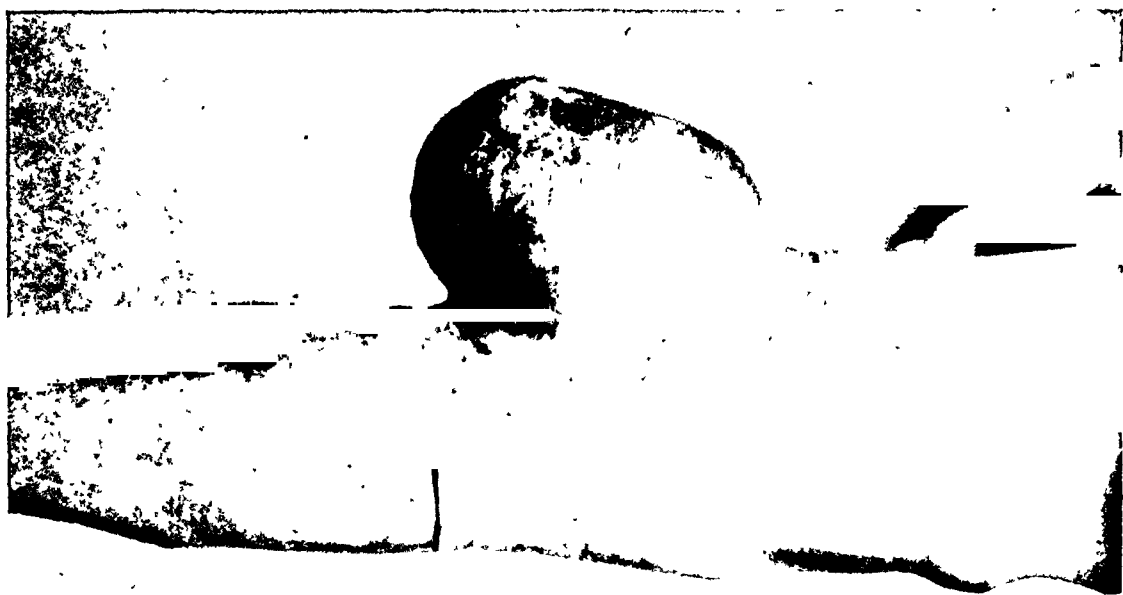


FIG. 5.—Large pre-patellar bursa of the left knee.

fusely, but could be controlled by pressure. Joint motion was not restricted. There was no pain nor tenderness. Further examination disclosed similar but smaller tumors which were uniformly firm; one just below the patella of the right knee and the other distal to olecranon of the left below. (Figs. 6 and 7.) The overlying skin was not ulcerated. The inguinal glands were readily palpable but not unduly enlarged. The epitrochlear nodes bilaterally were enlarged. Further physical findings were essentially negative.

Twelve years previously small lumps were noticed almost simultaneously on both knees and left elbow. These gradually increased in size, never giving any pain. Three years ago the patient had a fall on left knee. Since then it had become more swollen. At times his trousers rubbed the skin and it became abraded. For past two days it had bled enough to keep a bandage on it. The present hæmorrhage occurred while walking.

He gave a history of a Neisserian infection in 1898; typhoid fever, influenza and rheumatic fever involving right knee; alcohol in moderation. He worked as a laborer, and at intervals for seventeen years had to support himself on his knees and left elbow for four hours at a time while filling a coal bin. The Wassermann blood reaction was anti-complementary, and the Kahn test weakly positive. Röntgenologically the tumor

mass showed no invasion of bone, but small, calcified areas. Previous to operation if dressing was removed from left knee, bleeding was profuse. The differential diagnosis stood between gumma, traumatic bursitis and neoplasm.



FIG. 6.—Comparative size of bursa right knee.

January 20, 1931, under general anaesthesia, the growths were removed; they were found to be well encapsulated but very adherent to the neighboring structures due to



FIG. 7.—Subolecranon bursa.

dense scar tissue. The wounds were closed without drainage and healed by first intention. Three months after operation no recurrence had taken place.

KLIPPEL-FEIL SYNDROME

KLIPPEL-FEIL SYNDROME

DR. DE FOREST WILLARD, and, by invitation, DR. JESSE T. NICHOLSON read a paper with the above title.

DR. DEFOREST P. WILLARD said that the fusion between the first cervical vertebra and the occipital bone is apparently not quite so rare as one would be led to believe from the literature. In teaching osteotomy for a good many years, he could recall several cases of adults in which the occipital bone was intimately fused with the occipital vertebra. We find not infrequently osseous fusion between the first cervical vertebra and the articular surfaces of the occiput. These cases are very often wrongly diagnosed as tuberculosis of the cervical vertebra. That is one of the reasons they come from the dispensary diagnosed as old or beginning Potts' disease and from the appearance of the neck it is rather hard to make a differential diagnosis. Unless the history is very clear it can be mistaken for Potts' disease due to the low-grade inflammation.

DR. JESSE T. NICHOLSON said that regarding the differential diagnosis from cervical Potts' disease, the principal features are the absence of muscular rigidity, the freedom from pain with motion and the bone architecture as shown by the Röntgen film.

MEMOIRS

ASTLEY PASTON COOPER ASHHURST, M.D.

1876-1932

ASTLEY PASTON COOPER, the son of the scholarly John Ashhurst, Jr., was born in Philadelphia in the Centennial Year, 1876. He received all of his early school education and medical training in that city. The Bachelor of Arts degree in 1896 and the degree of Doctor of Medicine in 1900 were con-



ASTLEY PASTON COOPER ASHHURST, M.D.

ferred by the University of Pennsylvania. After his graduation from the Medical School, from 1900 until 1904, he was an interne, first at the Children's Hospital and later at the Episcopal Hospital.

From 1904 until 1914 he served an apprenticeship in various dispensaries. In 1913 he was elected Surgeon to the Orthopedic Department and Associate Surgeon to the Surgical Service of the Episcopal Hospital. In 1914 he was appointed Surgeon to the Orthopedic Hospital and in 1915 he was promoted

to Surgeon at the Episcopal Hospital. For nine years, 1911 to 1920, he was an Instructor in Surgery at the University of Pennsylvania and for several years prior to his resignation in May, 1932, he had been Professor of Clinical Surgery at his Alma Mater. He was an authority on medical history.

He loved to teach and the students respected his knowledge and his mastery of fundamentals, and, in spite of a slight hesitancy in speech, his lectures and quizzes were always popular.

As a surgeon he was methodical in the superlative degree, even such details as choosing the instruments, or handling of the instruments, or applying the bandage, all of them were his job and a surgeon's duty. His carefulness did not make him a putterer with a scalpel and needle; his knowledge of anatomy made that impossible. Nor was his care exhibited only in the operating room: he made his own examination, his own diagnosis, looked at the X-ray plates, consulted with his medical confreres, and saw with his own eyes the pathological sections.

As an author he possessed few equals. His purely scientific articles were clear and simple, and his essays were examples of rhetoric that reflected his scholarly attainments. His magazine articles fill four large volumes, and, between the years 1902 and 1920, he was the author of eighty-two magazine articles, co-author in ten others, wrote numerous book reviews, edited two volumes of the Episcopal Hospital Report, was a co-author of two text-books, the author of a monograph, and wrote his own work, "Surgery: Principles and Practice."

Astley Ashhurst found time to serve his country. He believed in preparedness and put his stamp of approval on the idea by attending the Officers Training Camp at Plattsburg in 1916. After America's entry made the last war a world war, he organized Base Hospital 34 at the Episcopal Hospital and was its first Director. He went to France with the unit on December 15, 1917, and returned to America in January, 1919. In France he served at the front with the French and the Americans, and after the Armistice was appointed as a consultant to the hospital centre at Savenay. On his return home and until his discharge from the army on April 16, 1919, he acted as Chief of the Surgical Service at the Walter Reed Hospital. He entered the army as a first lieutenant and at the time of his discharge he had been promoted to colonel. For his army service he received a citation for "exceptionally meritorious and conspicuous service with Base Hospital 34."

In 1929 it was noticed that he was having dizzy spells. In the latter part of May, 1930, while driving on the Roosevelt Boulevard he had his first attack of cerebral thrombosis and crashed into a tree. He got out of his car, took a picture of the crash and then made his way to his office by trolley and bus. On his arrival home several hours later it was noticed that he had a left hemiplegia. After months of rest he entirely recovered the use of his hand and leg and returned to operating and teaching. However, in the latter part of August, 1932, he had a second attack of thrombosis from which he rallied, but a third attack caused his death September 19, 1932.

EDWARD T. CROSSAN

DAVID BARROW, M.D.

1858-1932

DR. DAVID BARROW, Kentucky's most distinguished surgeon, died at his home in Hampton Court on Thursday, August 18, 1932, after an illness of six months.

Doctor Barrow was born at "Afton Villa," the Barrow ancestral home near St. Francisville, Parish of West Feliciana, Louisiana. Born August 31, 1858, son of David Barrow, of St. Francisville, Louisiana, and Susan



DAVID BARROW, M.D.

Mitchum Woolfolk, "Oak Hill," near Versailles, Woodford County, Kentucky. Doctor Barrow received his early education at Kentucky University, Lexington, Kentucky, and the University of Louisiana at Baton Rouge; his medical education at Tulane University; and post-graduate work at Bellevue Hospital, New York City.

Doctor Barrow received his M.D. degree from Tulane on March 19, 1880, and practised in New Orleans before coming to Lexington in May, 1887. For many years Doctor Barrow, like all physicians of that date, did

a general practice but was looking forward to confining his work to surgery. This he did. During his long professional career, he received many deserved honors. He was a member of a large number of organizations and had the distinction of being the only surgeon in Kentucky who was a Senior Fellow of the American Surgical Association and the Southern Surgical Association. His World War record is notable, having organized the Good Samaritan Hospital Unit, known as Base Hospital No. 40; commissioned as Major August 11, 1917; sent to Camp Zachary Taylor; then overseas to Southampton, August, 1918; was sent to France, then back to London and was commissioned Lieutenant-Colonel August 28, 1918. He was commanding officer of Base Hospital No. 40 until his return to the United States March 6, 1919.

Doctor Barrow organized the Lexington Clinic in 1917. Its decided success was largely due to his operative skill, his discriminative diagnostic ability, his rare judgment, and his personal charm.

Doctor Barrow made many contributions to medical and surgical literature. These were published in the journals of that date, and the transactions of the State Medical Association.

The death of his wife—Mary Blunt Parham, the sister of Dr. Frederick W. Parham, of New Orleans—in November, 1908, the tragic death of his youngest son, David, in July, 1914, and that of his oldest son Dr. Woolfolk Barrow in July, 1923, would have crushed the spirit of most men, but his indomitable will and consummate courage sustained him in this supreme trial; his brave soul carried on to the end.

The Lexington Herald, of August 19, 1932, contained these words of eulogy:

A great surgeon, a beloved physician, a noble gentleman, a revered citizen was David Barrow. In every sphere in which he played a part, through every contact his influence was noble. It is difficult even to indicate, impossible adequately to estimate the influence Doctor Barrow exerted through the long years he gave to profession and to friends. Gentle, with the never failing gentleness of high courage and sweet tolerance; generous beyond limit of acceptance by others; faithful to obligation, great or small, his life was a benediction.

J. W. PRYOR.

WILLIAM WILLIAMS KEEN

1837-1932

It is difficult to write a comprehensive memoir of Doctor Keen because of the abundance of material from which to draw.

Doctor Keen's accomplishments in the field of medicine and in civic and



WILLIAM WILLIAMS KEEN, M.D.

educational affairs were remarkable and could have been obtained only by one possessed of his earnestness, enthusiasm and love of work, none of which had abated when he had passed into his ninth decade. During the forty years that the writer was more or less intimately associated with him, he was impressed constantly with his enthusiasm, his optimism, his deep religious convictions and his tireless energy. His multifarious duties and engagements

throughout his career were met with the most exact promptness and given the most careful consideration. He often said that it was the busy man who was always prompt and who never forgot an engagement. Even in the busiest period of his very busy life he was rarely late for a lecture, an operation or a consultation.

William Williams Keen was born in Philadelphia January 19, 1837, was graduated from Brown University in 1859 and from the Jefferson Medical College in 1862. He at once entered the Army as acting Assistant Surgeon and soon became generally known because of his association with Mitchell and Morehouse in their notable work and publications on nerve injuries. After the War, he spent two years in Europe.

In 1866, he returned to Philadelphia, began the practice of medicine and soon acquired teaching positions. For nine years he lectured on pathological anatomy at the Jefferson Medical College. During the same period he conducted the Philadelphia School of Anatomy in which he had been preceded by so many distinguished surgeons. From 1876 to 1889 he was Professor of Artistic Anatomy at the Philadelphia Academy of Fine Arts and from 1884 to 1889 Professor of Surgery at the Women's Medical College. During the period between 1866 and 1889 Doctor Keen became known in the world of surgery largely through his contributions to literature. Up to the end of this period, he had no large hospital service, but was on the surgical staff of St. Mary's and St. Agnes' Hospitals and developed a large surgical practice.

In the year 1889, on the death of the younger Gross, he was elected one of the Professors of Surgery at the Jefferson College, the other being John H. Brinton. This election marks a distinct epoch in the surgical career of Doctor Keen. He gave up his other hospital and college positions and devoted himself assiduously to teaching, to his surgical service in the Jefferson Hospital, and to writing. His fame and reputation spread rapidly and he soon became a conspicuous figure in the world of medicine. Keen's lectures were all carefully prepared and he always had before him synopses which were carefully followed, rendering note-taking easy on the part of the student. Doctor Keen kept accurate notes of all his hospital patients in his own office which enabled him easily to report his experiences with accuracy. His well-ordered life made possible the accomplishment of work which would easily have staggered any two men whose lives were not so well organized. It was, I am sure, this characteristic of order and arrangement which enabled him to write so extensively and to read not only everything that was worth reading in surgical literature, but a mass of other papers and books relating to science, political economy and religion.

As an operator he was bold but very painstaking and careful. He rarely showed hesitation and never a lack of self-confidence. But for these qualities he could never have contributed so much to the advancement of surgery, particularly that of the brain. He was America's first "brain surgeon" and soon gained and held preëminence in this field of surgery. It is impossible in a brief sketch such as this to discuss or even enumerate Doctor Keen's con-

tributions to literature, but the following, prepared by himself, will give some idea of the wide scope of his writing.

Reflex Paralysis and Gun Shot Wounds and Other Injuries of Nerves (both with Weir Mitchell and Morehouse), 1864; Keen's Clinical Charts, 1870; History of the Philadelphia School of Anatomy, 1874; Early History of Practical Anatomy, 1870; History of the First Baptist Church of Philadelphia, 1898; Surgical Complications and Sequels of Typhoid Fever, 1898; Addresses and Other Papers, 1905; Animal Experimentation and Medical Progress, 1914; The Early Years of Brown University, 1764-1770, 1914; Ether Day Address, 1916; Treatment of War Wounds, 1917; Surgical Operations on President Cleveland, 1917; Clover Lectures at Brown University on Medical Research and Human Welfare, 1917; Selected Papers and Addresses, 1922, Editor: Heath's Practical Anatomy, 1870; Diagrams of the Nerves of the Human Body, by W. H. Fowler, 1872; American Health Primers, 1879-1880; Holden's Medical and Surgical Landmarks, 1881; Gray's Anatomy, 1887; American Text-Book of Surgery with J. William White, 1892, 1903; I Believe in God and Evolution, 1922; Everlasting Life, 1924; Keen's System of Surgery, eight vols., 1906-1921.

Doctor Keen was an enthusiastic patriot and it was with pride that in his later life he referred to his military service in three wars.

Honors were literally heaped upon him; he was elected president of practically every society of which he was a member, among them the College of Physicians of Philadelphia, the American Medical Association, the American Surgical Association, the International Society of Surgery and the American Philosophical Society; he was an honorary member of most of the European surgical societies and held honorary degrees conferred by the following institutions: Brown, Northwestern, Toronto, Edinburgh, Yale, St. Andrews, Pennsylvania, Upsala and Harvard. There have been few American surgeons so universally respected and honored.

Aside from his professional work Doctor Keen gave a great deal of his time to matters of education, civic improvement and to his church. His only recreations were reading and travel. A continental trip was usually made in the summer, and in his late life his travels were completed with a trip around the world. At the time of his death on June 7, 1932, he was the oldest Fellow of this Association both in years and duration of membership, having been one of the original Fellows. His interest in the Association was very deep and his attendance at the meetings was regular even after his retirement. The year of his Presidency was in 1898.

The death of this great surgeon June 7, 1932, in his ninety-sixth year, not only saddened the hearts of the older Fellows of the Association, but also of those much younger who had drawn an inspiration from his enthusiasm, his energy and his accomplishments.

J. H. GIBBON.

EDITORIAL ADDRESS

The office of the Editor of the *Annals of Surgery* is located at 386 Park Street, Upper Montclair, New Jersey. All contributions for publication, Books for Review, and Exchanges should be sent to this address.

Remittances for Subscriptions and Advertising and all business communications should be addressed to the

ANNALS OF SURGERY

227-231 South Sixth Street
Philadelphia, Penna.

ANNALS *of* SURGERY

Vol. XCVII

APRIL, 1933

No. 4

EFFECTS OF SYMPATHETIC NERVE SURGERY IN CERTAIN INTESTINAL CONDITIONS *

BY FREDERICK S. WETHERELL, M.D.

OF SYRACUSE, N. Y.

THE anatomy of the sympathetic nervous system has been carefully studied and is probably, at the present time, as definitely established as the anatomy of other parts of the body. It is, undoubtedly, true that many operations on the sympathetic system in the past have resulted in failure because of the indefiniteness of both the anatomical and physiological features pertaining to these nerves. It is probably because of these failures that this type of work fell into disrepute for some years following the beginning work of some of the early investigators. However, much advance has been made in the past decade by research of both foreign and American workers.

The sympathetic nervous system, it is well known, carries impulses which concern not only smooth muscle activity, but also the transmission of pain. In the present communication we are limiting ourselves to a consideration of the action on certain smooth muscle fibres; *viz.*, those of the internal rectal sphincter and lower colon.

The results of the excision of the superior hypogastric plexus (pre-sacral nerve) show quite definitely that impulses are transmitted through this plexus, which maintain the tone of the internal rectal sphincter. Releasing the tonicity of the sphincter allows the fecal mass to come down and thus impinge on the external sphincter, which is under voluntary control. The stimulus of the mass in this area is readily perceived by the patient, and by immediate response on his part, a regular bowel habit is gradually acquired. This is, undoubtedly, the *modus operandi* by which the end-results are obtained in that group of cases, the outstanding feature of which is an inability to have regular defecations, resulting in gradual and repeated filling of the colon with feces, to the point of impaction. The feature of impaction is noted most constantly in both Hirschsprung's disease and severe rectal obstipation.

The satisfactory results obtained by Adson and Learmonth, in the treatment of Hirschsprung's disease, first by excision of the lumbar ganglia, and later by resection of the pre-sacral nerve fibres, alone bear evidence to the fact that the internal sphincter contractility is thereby definitely lessened. It was their work which prompted us to attempt this operation in Hirschsprung's disease. Later, following a report of Rankin and Learmonth¹ of

* Read before the American Association of Obstetricians, Gynecologists, and Abdominal Surgeons, September 12, 1932.

a case of severe, chronic, rectal type of obstipation, greatly benefited by pre-sacral neurectomy, we were again prompted to try the method in one of these cases. They report one case and describe the technic. Theirs, and one reported by Flothow,² are the only cases we have been able to find reported in the literature.

Feeling, as we did, that a long enough time, at least a year, should elapse before end-results could be reported which would be of any value, we have waited until now to cite the two cases reported herewith. Although the report of two cases does not, by any means, constitute a so-called series, the fact must be taken into consideration that the number of cases of this type, presenting themselves for treatment, while not rare, is, nevertheless, not common. Furthermore, the results obtained seem to justify the report. We feel, too, that it is quite possible that more cases of the constipation type may present themselves, when the fact is better known to the profession that there is hope for relief after other methods have failed. We have recently operated upon another case of Hirschsprung's disease, but it is, as yet, too early to report the final result. The patient, a boy of eight years, operated upon August 29, 1932, has had daily bowel movements without enemas or cathartics, to date, September 30.

CASE XI.—*Hirschsprung's Disease (Megacolon)*.—A female child, eight years of age, was admitted to the pædiatric service of Syracuse Memorial Hospital May 14, 1930. She was suffering from typical Hirschsprung's disease. The abdomen was greatly distended and peristaltic waves were visible. X-ray examination showed an enormously dilated colon. The child's mother was of a poor mental type and her father was a drunkard. Since babyhood the mother had noticed that the child often experienced considerable difficulty on defecation. Hard masses of fecal material caused a great deal of pain in passing—so much so that the child began to avoid having bowel movements. After a time this necessitated calling the family physician, who was obliged to remove impacted fecal material by manual means about every five weeks. After the lower bowel had been thoroughly emptied, fair results were obtained by enemas for a time. All attempts to establish regularity of defecation, however, were of no avail. This meant repeated manual emptying of the bowel and a number of trips to the hospital—she was admitted to this hospital four times during the year 1929. The child had a definite neurasthenic makeup, was undernourished, and very much under size. Even though the mother was able to obtain fairly good results with enemas, at times, the regularity of the treatment was interrupted by the necessity of her leaving home to work, due to the father's state of chronic inebriety. These facts are mentioned to give a picture of the child's environment and temperament, and bear directly on the end-results of the operative procedures for attempted relief of the pathological condition. A left, lumbar, sympathetic ganglionectomy and ramisection of the second, third, and fourth lumbar ganglia was performed May 26, 1930. The child's recovery was uneventful, and she was allowed out of bed on the seventeenth day. Oil enemas were given beginning the third day after operation, and one-half ounce of mineral oil was given by mouth, night and morning, beginning the fourth day. Bowel movements were regular following this treatment and after twenty-six days it was discontinued. She remained in the hospital five weeks, and her bowels moved every morning before rounds were made. The promise of a dime in the event that this happened was, probably, of assistance in obtaining this result. The child was discharged in excellent condition. She was readmitted in November, 1930, and again in January, 1931. Each of these times the colon was full but was easily emptied, and while in the hospital daily movements were again obtained. Because of her work, the mother had been unable to carry out instructions, and the child had been left very much to her own resources. September 24, 1931, she was again admitted, and this

time, because not all of the motor fibres of the internal sphincter are severed by the removal of the second, third, and fourth ganglia, the proposition that the superior hypogastric plexus should be removed, was taken under advisement. It was felt that, probably, if this were done, all tone impulses then being blocked, a permanent result might be obtained, despite the difficulty of proper supervision at home. This operation was performed October 22. The descending colon was found to be practically normal in size—the transverse, somewhat larger. Oil enemas were given for four days and mineral oil by mouth throughout the child's stay in the hospital. Daily bowel movements were again obtained, and she was discharged after an uneventful recovery November 7. She was sent to a children's convalescent camp. There she reported to the supervisor that her bowels moved daily. No direct check was made on this statement. In April, 1932, she was again admitted to the hospital with the descending colon filled with feces. Emptying was easily effected by colonic irrigation. Close questioning revealed the fact that the child had a constant fear that she might have pain when her bowels moved. The beginning of this fear was traced back to the many times that painful manual extraction had been performed. Much reassurance and checking on bowel action was finally resulted in the establishment of a regular habit, which has now been in effect for over five months.

CASE II.—*Severe Rectal Type of Obstipation*.—H. F., male, age forty years, a priest, was admitted to St. Joseph Hospital, Syracuse, N. Y., February 1, 1931. His chief complaint was a severe, chronic obstipation, with nausea, anorexia, and general weakness. This obstipation was of twenty-two years' duration despite numerous sojourns in hospitals and clinics for treatments, and surgery, in attempts to correct the condition. If no attempts were made to obtain a movement by means of enemas or cathartics he would go ten to fourteen days without a defecation. After a time even these expedients were often of no avail. A feeling of fulness in the left side of the abdomen developed during this period of filling of the terminal portion of the bowel, and he would have attacks of nausea, sometimes vomiting, and a general feeling of malaise and anorexia. He never had difficulty in passing gas. There was a gradually increasing difficulty in his ability to attend to his priestly duties. Because of his voluntarily restricted diet, his general strength was at low ebb. His first hospitalization was in 1920, at which time his appendix was removed because of the recurrent attacks of nausea and vomiting. His condition was not improved following the operation. In fact the obstipation grew increasingly worse. He was readmitted in 1922, and during a two-weeks' period of observation he was given a series of colonic irrigations. His bowels had not moved for six days previous to his admission. He was relieved of his distress, but the relief was short-lived, the entire sequence of events recurring after his discharge from the hospital.

In 1929, he again entered the hospital, and a gastro-intestinal röntgenographical study was made. This resulted in negative findings. He left the hospital at the end of a week, unimproved. Shortly thereafter he went to a clinic in the mid-west for examination and treatment. He was given a special diet, and told to increase his physical activities. After a three-weeks' stay he returned home somewhat improved, but despite observance of the diet, there was a gradual return of the obstipation. There was a marked increase in nervous instability, anorexia, and inability to work. His insistence that something be done for him, and the thought of his family physician that there might be a lower sigmoid obstruction, caused by adhesions, was the reason for his admission at the time we first saw him. He was emaciated. There was a slight acneiform eruption on the face. The thyroid gland was normal in size, easily palpable. There was a coarse tremor of the hands. A basal metabolic test showed a rate of minus 17.4 per cent. At the time of the test his pulse was 56. These findings, along with lack of strength, and general nervous instability, place him in the group of "chronic nervous exhaustions," easily explainable, when the entire foregoing history is taken into consideration. There was a sausage-shaped mass in the left lumbar and left iliac regions of the abdomen, presumably fecal material in the descending colon and sigmoid. It disappeared after colonic irrigation. A barium enema showed a slight hyperperistalsis of the descending colon. Proctoscopic and sigmoidoscopic examinations revealed no

gross pathology. February 11, 1931, a left lumbar ganglionectomy and ramisection of the second, third, and fourth ganglia was done. He had a stormy convalescence, occasioned by hiccoughs, lasting seven days. On the thirteenth day after operation he was allowed to be out of bed, and he had two defecations without the aid of enemas. Mineral oil, one ounce, was given night and morning. From then on, until the present time, at first for three months with the assistance of mineral oil, and since then unaided, there have been one or two defecations a day. No particular attention is being paid to the diet; there has been a forty-pound gain in weight; and there is a complete change in the patient's outlook on life. An important phase in the after care of this case was the repeated assurance that there was no reason why regular bowel movements should not continue, and that a regular full diet should cause no difficulties.

In both these cases the point was stressed that a bowel habit with movement after breakfast was of utmost importance, and in each case this is now taking place with clocklike regularity.

SUMMARY.—Despite the headway which has been made in the past decade along the lines of research and practical application of the results of studies on the sympathetic nervous system, one is often amazed at the diversity of reports of end-results in patients operated upon for like maladies, and presumably, if the operator is to be believed, a technic not varying in the least.

Like so many advances in the science of medicine, the method of trial and error has prevailed in sympathetic nerve surgery, with a gradual narrowing down of the indications, and the usual moderation of initial enthusiasm. When considering this type of surgery and its end-results, one thing, it seems, must be kept in mind constantly, and that is that each sympathetic nervous system is a part of a particular individual. The entire makeup of the person suffering from a difficulty which can, at least in part, be traced to this system, is usually, to a greater or lesser degree, one of nervous instability. Common examples of these types are the hyperthyroid individual, or the one with Raynaud's disease. One must not forget that the higher centres are minutely inter-related with the activities of the sympathetic nervous system as exemplified, for instance, by the vasodilatory, and the pilomotor activities during fright. Outside influences filter through the sensorium and react, sometimes very rapidly, on the sympathetic system, and one of these outside influences is the attitude of the attending physician. By this we mean that the surgeon attempting this type of work, and expecting good results, must have a full understanding of the makeup of his patient. He must be willing, not alone to perform the operation, but thereafter, to closely follow the patient, using all of the applied psychology at his command. He is dealing with a type of individual which demands this sort of post-operative care almost more than any other. The fear of the patient that the chronicity of the affection under treatment may not be modified is, in our experience, an outstanding factor. Repeated reassurance, therefore, is of paramount importance.

BIBLIOGRAPHY

- ¹ Rankin, F. W., and Learmonth, J. R.: Section of the Sympathetic Nerves of the Distal Part of the Colon and the Rectum, in the Treatment of Hirschsprung's Disease and Certain Types of Constipation. *ANNALS OF SURGERY*, vol. xcii, pp. 710-720, 1930.
- ² Flothow, Paul G.: Surgery of the Sympathetic Nervous System. A Report of Fourteen Sympathetic Ganglionectomies. *Am. Jour. Surg.*, vol. x, No. 1, pp. 8-18, 1930.

THE SURGERY OF THE SYMPATHETIC NERVOUS SYSTEM

OPERATIVE NOTES BASED ON 273 OPERATIONS

BY STEELE F. STEWART, M.D.

OF LOS ANGELES, CALIF.

THE surgery of the sympathetic nervous system is unknown to and feared by most surgeons. The arrangements of the sympathetic fibres, however, simplify greatly the surgical problem, but likewise produce effects other than the ones sought. Thus the cervical ganglia receive their cerebral influences through the white rami of the first five or six dorsal nerves, transmitting the stimuli by gray rami to the eye, salivary glands, heart, bronchi, the sweat glands, erector pilæ and blood-vessels of the arm, neck and scalp of the same side. It is therefore patent that a section of the sympathetic trunk below the first dorsal nerve and ascending rami of the first dorsal nerve will produce maximal effects in the organs and areas indicated, so far as the removal of central control of the sympathetic is concerned; however, it would not remove any sympathetic ganglionic autonomy, if such exists. In like manner, the central sympathetic influences to the hind quarters enter the sympathetic chain from the sixth dorsal to the upper lumbar segments, and are redistributed by gray rami to the lumbosacral plexus chiefly from the second lumbar downward. Hence a section of rami from the second lumbar to the fourth lumbar, and of the trunk below this level, would produce maximal effects in the lower extremities with associated effects on pelvic viscera.

Between 1925 and December 31, 1931, we have operated 273 times in connection with this system, and certain surgical lessons are outstanding. These notes are written to make the surgery of this system more understandable.

In 1923 and 1924, Royle⁶ described approaches to the lumbar sympathetic trunk and brachial rami. The transabdominal approach,¹ with reflection of the peritoneum from beyond the cæcum or sigmoid to the mid-line, we feel is an unnecessary entry of the peritoneal cavity attended by shock and a risk of ileus immediate and remote, and its very magnitude and location open the way for potentially enormous post-operative hernia, and hence it has been rejected as unsound surgically and physiologically.

Lumbar Operation.—The original approach of Royle is entirely adequate for any surgery on the lumbar sympathetic trunk. It centres around the trigonum lumbale and consists of an angular incision from the eleventh rib to the trigonum lumbale and along the iliac crest for six to eight centimetres. The patient's body is best rolled toward the opposite side through an angle of 45° to 60° and the loin put on stretch. Carrying the incision down to the iliac crest and the lumbar muscles it is advisable to bluntly dissect the outlined flap well forward and to loosen the posterior and inferior margin of the

incision in order to secure an adequate exposure. In most cases the trigonum lumbale is easily distinguishable, but occasionally one muscle layer blends into the next without any line of demarcation. This has occurred bilaterally and has necessitated a direct myotomy from the eleventh rib to the crest of the ilium. The external oblique is raised on a blunt dissector and divided close to the iliac crest. The internal oblique is reflected in the same way. In this dissection superficial nerves are frequently found and cut, but their division leaves only a sense of numbness below the area of operation.

In most individuals a muscularis transversalis can be definitely identified, although in a fair number of individuals only a dense fascia is recognizable. This fascia is cut or broken through well posteriorly and is opened to the full extent of the incision. Henceforward the operation is carried on by blunt

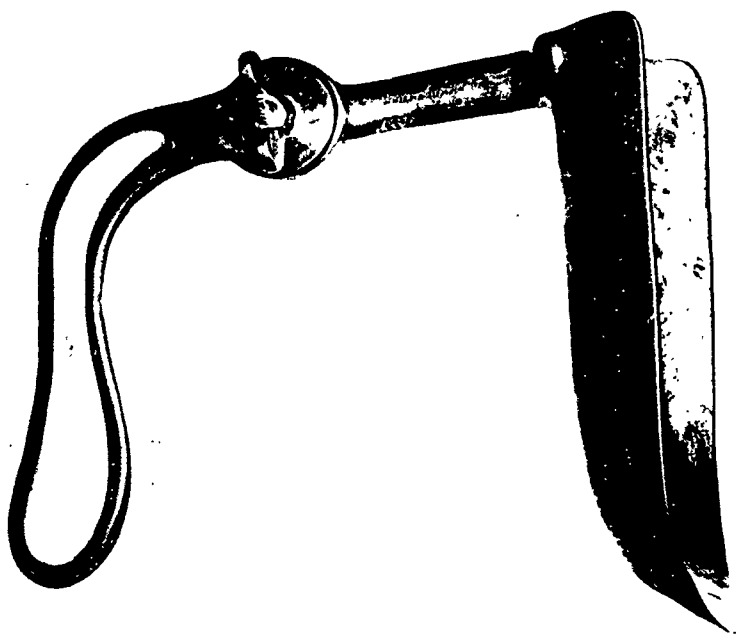


FIG. 1.—Peritoneal retractor of Royle's. The handle is detachable, and there are four sizes of spoons for various sizes of patients.

dissection. The peritoneum is pushed forward from its attachment to the posterior abdominal wall, carrying with it the ureter.

As the sympathetic trunk lies anterior to the psoas muscle, it is important to remember that the psoas rises abruptly from the posterior abdominal wall to the height of the vertebral body. One should guard against dissecting between the psoas and the posterior muscles which would lead one into the region of the transverse processes.

Retractors are useless until the intervertebral discs are felt. Those designed by Royle are most satisfactory. (Fig. 1.) They are made in several sizes, and if one is doing a large volume of work all sizes will be required. The spoon retractor stretches the peritoneum forward exposing the ureter attached to its posterior surface. The surface of the psoas is cleared of areolar tissue revealing the tendon of the psoas parvus and ilio-inguinal nerve.

Twice the tendon of the psoas parvus has arisen high above the magnus barring all advance. Its division has given no subsequent difficulty.

The psoas retractor (Fig. 2A) of Royle is most effective in rolling the psoas out of the road exposing the spino-psoas sulcus filled with a triangular mass of glandulo-areolar tissue. It is useless to search this mass for the sympathetic trunk as the latter lies directly on the spinal ligaments. Bluntly reflecting this small mass of tissue anteromedially, the trunk of the sympathetic can be felt or seen on the left side lying external to the aorta. On the right side a much more delicate situation obtains for the sympathetic trunk lies beneath the vena cava. This requires most careful dissection, not only because of the proximity of the vena cava, but because in about 5 per cent. of patients one or more vertebral veins overlying the sympathetic connect

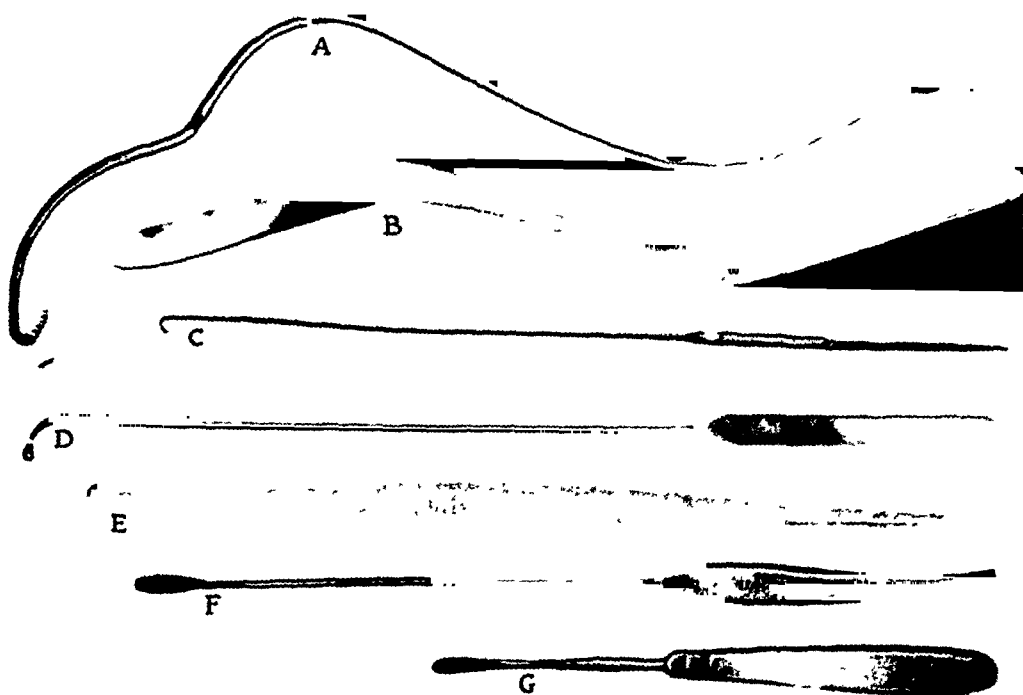


FIG. 2.—Instruments to be numbered from above downward A, B, C, D, E, F, G. A—Psoas retractor of Royle's. B—Double-ended spoon reflector for use in cervical operations. C—Small hook used in picking up sympathetic. D—Large bulb end hook used in holding abdominal trunk. E—Blunt dissector of Royle's. F—Long slender dissector used in isolating sympathetic trunk in both lumbar and cervical operations. G—Short dissector used in superficial tissues of the neck.

immediately with the vena cava. These veins bind down the sympathetic trunk and rami usually accompany the vertebral vessels.

The sympathetic trunk is secured by a slender, sharply curved, blunt hook (Fig. 2C); the end of the hook should be directed backward. Once secured a large ball-ended flat hook (Fig. 2D) is inserted in a reverse direction, lifting the ganglionic chain and depressing the great vessels. Once secured there is little cause for confusing its identity, for, regardless of location of the sympathetic, one is impressed with its tautness, tautness such as one would encounter in lifting the string of a violin.

The ganglia are not distributed with mechanical precision. In the majority of patients they follow the text-books quite closely. However, in about 5

per cent. of patients one finds an arrangement similar to the cauda equina, the trunk descending to a massive ganglion in the region of the second and third lumbar vertebræ when a veritable sheaf of rami extend distally. In a similar number the lower portion of the chain appears as a fine filament, the rami coalescing into one enormous ramus. Hence, if the ganglionic chain cannot be identified below it should be sought higher up.

The upper level of dissection is recognized by the direction of the rami. The middle and lower rami in their general direction proceed caudad and dorsally; at the level of the second lumbar the rami pass cephalad and dorsally and there is usually one large ramus present at this level.

Beside the rami which pass between the spine and psoas, other rami pass toward or beneath the great vessels and may be visceral or commissural rami communicantes. These intercommunicating rami may determine some of the contralateral effects described by Orbeli⁵ in his Hertzstein lectures. All rami are avulsed, leaving the chain free of lateral connections.

It is sometimes possible to mobilize all the ganglia and rami before dividing any; again it will be necessary to avulse each ramus before securing another. If overlying veins are found an accompanying ramus is almost surely to be found, the trunk is divided and carefully drawn from beneath the vertebral vein. Which rami are to be divided depends on the operative indication and does not come within the scope of this paper. In all cases the trunk should be severed as low as possible. The ganglionic chain may be removed or not according to caprice, but no better results are obtained by ganglionectomy than by thorough ramisection and trunkotomy.

Royle⁸ found it inadvisable to do both lumbar operations at one sitting. This operation may be exasperatingly long or surprisingly brief. Our own records show that the time varies from seventeen minutes to one hour and fifty minutes, the longer time occurring in the earlier cases or larger individuals of the series. In children the present average is twenty-five to thirty minutes, and in adults fifty to sixty minutes. Severe bleeding has never been experienced, little shock has resulted, hernia have not followed, and no deaths have occurred in 174 operations.

Operations on the Dorsocervical Sympathetics.—Royle⁶ originally described a division of the sympathetic rami as they passed from the scalenus anticus to the brachial plexus. This operation did not give us satisfactory results as obtained in the lumbar operation, and Royle subsequently described a division of the sympathetic trunk between the first and second dorsal roots, which placed the brachial results on a par with lumbar ramisection. Royle's dorsal trunkotomy⁷ was an extension of the old brachial ramisection. Henry,³ in 1927, described a posterior approach to the sympathetic trunk by a resection of the transverse processes and a portion of one or more ribs. We tried both methods, and have entirely discarded the posterior approach as extremely shocking, more difficult of performance, and inferior in results. In spinal anomalies it is almost impossible to orient one's self by the approach

SURGERY OF THE SYMPATHETIC

of Henry. However, the trunkotomy of Royle is exacting to the most experienced.

The incision extends obliquely slightly upward and backward from the inner end of the clavicle for six to eight centimetres, rarely the subclavian vein lies immediately beneath the incision. The external jugular vein and platysma are divided in the line of incision. The sternocleidomastoid is divided, in whole or in part, revealing the omohyoid which is retracted upward. A layer of fat is next encountered, divided bluntly and retracted, revealing the shiny white brachial plexus coming from behind the scalenus anticus on which lies the phrenic nerve. The phrenic and the fifth nerves are connected higher up in the neck, but we have never divided this inosculation.

With the patient lying almost flat on his back, it is easy to lose one's

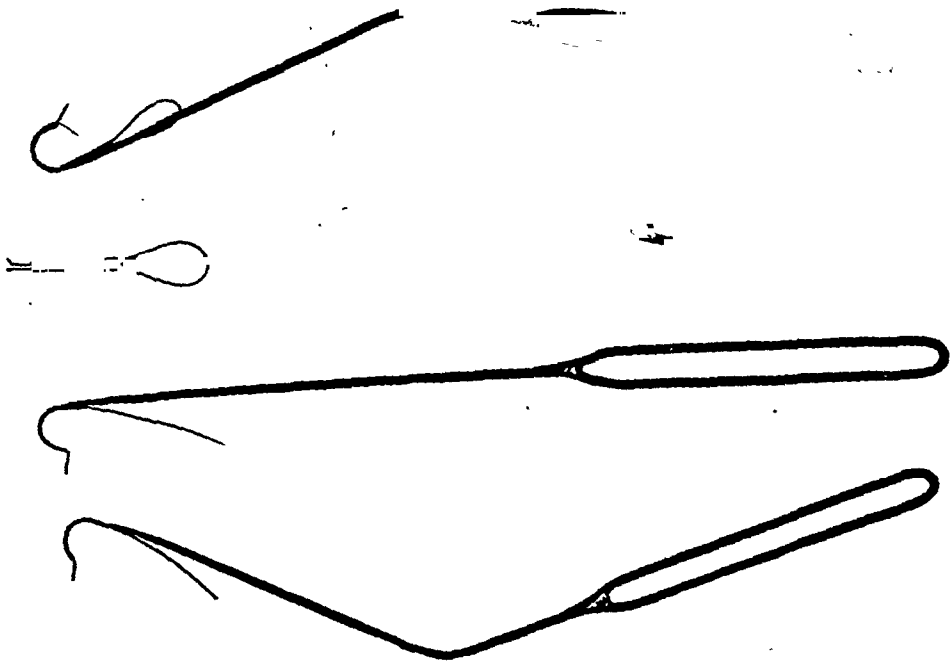


FIG. 3.—Curved ligature carriers, single and double with wires threaded through the curved needles.

sense of direction and dissect against the spine when the general axis of dissection should be downward toward the thoracic cavity between the scalenus anticus and the plexus. While doing this dissection one encounters very tough fibres passing from the posterior surface of the scalenus into the face of the nerve roots. These are the sympathetic rami and are not nearly as sizeable as Royle figured them in his Murphy Oration of 1924.⁶ These may be avulsed if necessary.

Immediately overlying the brachial plexus one finds the transverse cervical artery and vein. These may be tied and divided. Usually between the seventh and eight cervical roots one encounters the deep cervical artery and vein. This artery is very difficult to tie because of the short length of trunk exposed. To facilitate this ligation a special aneurism needle has been made

by fastening a blunted and bent eighteen-gauge hypodermic needle to a handle: through this the ligature can be passed directing the end of the ligature directly into one's forceps. (Fig. 3.)

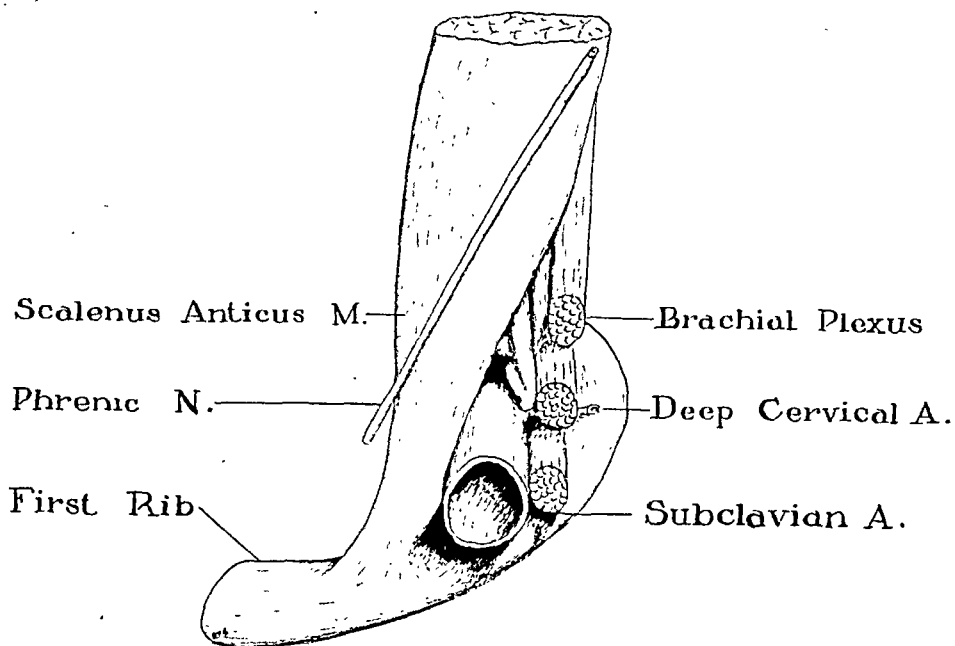


FIG. 4.

At the level of the eighth cervical nerve one encounters the first rib, although in one case a cervical rib was encountered between the seventh and

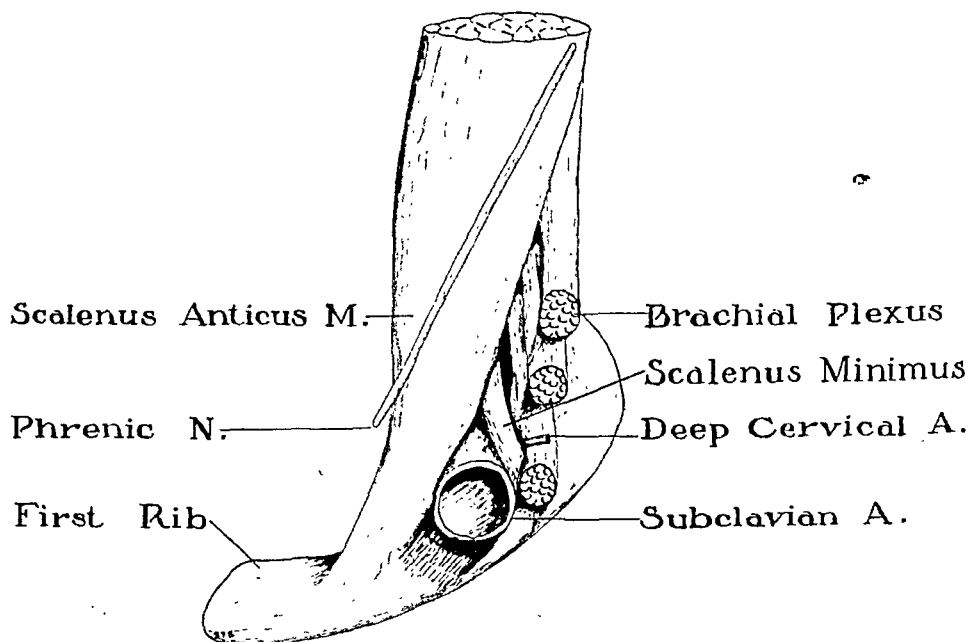


FIG. 5.

eighth nerves and had to be rongeured away. (Fig. 4.) Over the first rib, or the cervical rib, lies the subclavian artery. (Fig. 5.) In about one-half

SURGERY OF THE SYMPATHETIC

of the patients one finds a tendinous slip passing between the subclavian artery and the brachial plexus, this apparently is a division of the tendon of the scalenus anticus, but is described by Spalteholz as the scalenus minimus which inserts into the pleural dome and the first rib. It is always necessary to divide this tendinous slip for an adequate exposure. Closing the thorax above, the parietal pleura is reinforced by Sibson's fascia. The latter structure may be quite delicate, or it may be made up of very dense fibres. It is necessary to divide this fascia by either a blunt hook or dissector, being careful not to penetrate the parietal pleura. The parietal pleura is gently pushed from the ribs, working in a posteromedial direction. The first dorsal nerve can easily be found at this stage of the dissection winding its way from within the thoracic cavity around the first rib to join the under surface of the eighth cervical nerve.

One frequently encounters a swishing sound when working in this neigh-

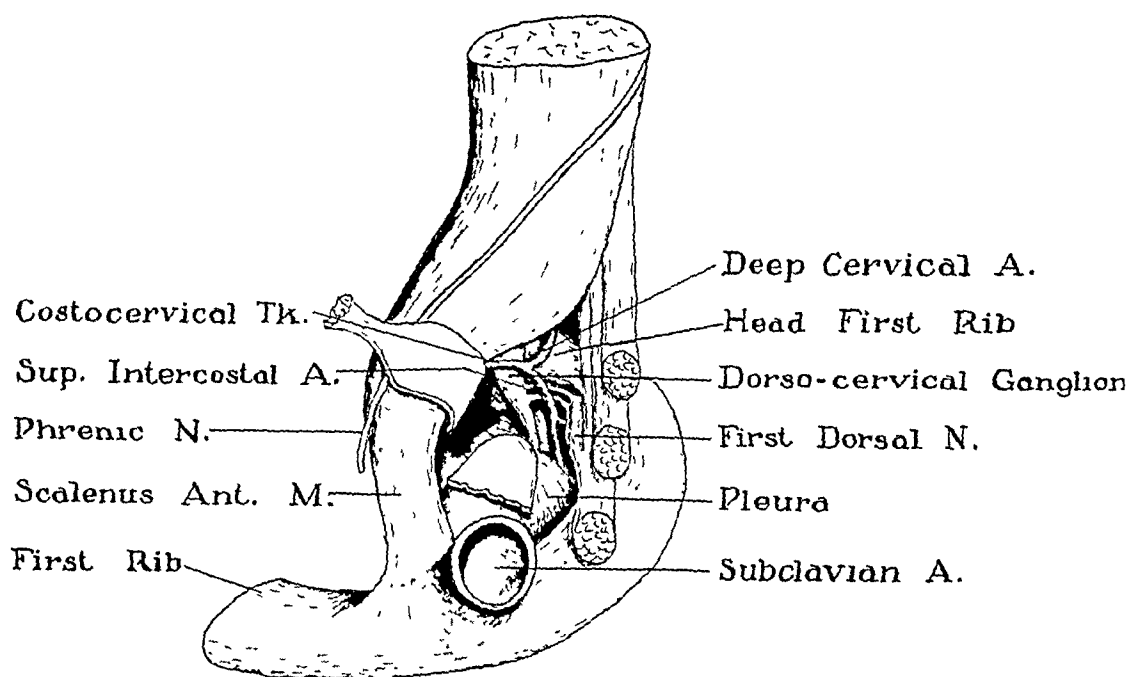


FIG. 6.

borhood, which is coincident with respiration, and one may see a hole, when the tissues balloon out, from which the sound apparently issues. This may occur without pleural puncture and may result in a cervical and facial emphysema.

Henceforward difficulties are immanent. While the sympathetic trunk lies at the costovertebral junction, another important structure lies just laterally which might be mistaken for the sympathetic trunk, *viz.*, the superior intercostal artery which supplies the upper intercostal spaces. (Fig. 6.) This artery passes backward over the medial surface of the pleural dome and turns downward over the inner surface of the costal cage. Accompanying this artery may be found a sizeable vein. Both the sympathetic trunk and the superior intercostal artery lie anterior to the intercostal nerves and run in the long axis of the thorax.

By means of long slender dissectors and hooks, one can pick up this artery and the sympathetic trunk. A long slender flat spoon is most helpful in reflecting light into this dark corner. (Fig. 2B.) The artery has the usual arterial appearance, but its small intercostal branches may simulate the rami. The sympathetic trunk lying just medial to this artery is usually white and taut, but it may be darkened and resemble a vein. One can assure himself by following the trunk upward and downward exposing ganglia and rami; or by inserting a hypodermic needle into the structure and watching for the appearance of blood. All the tests being negative, one divides the trunk with some reassurance, although with trepidation.

The sympathetic trunk at the dorsocervical junction may be of two main structural types: (1) The most common in our experience is a massive elongated ganglion which combines the first dorsal, inferior cervical, and possibly the second dorsal. (2) Less frequently the various ganglia are discrete. According to Kuntz⁴ rami from the second dorsal ganglion may pass upward to the first dorsal nerve.

The ganglionic trunk having been found, one holds it up on a small hook, and with a second hook determines the presence of branches and of the trunk superior to this ganglia, the trunk is very taut and it is necessary to exert considerable force in this attempt. The branches are divided and the trunk severed above the lower cervical ganglion and again below the first dorsal. Any branches coming from the second cervical ganglion to the first dorsal trunk are also divided. The tissue so loosened is removed from the operative field for pathological examination.

Suturing of the sternocleidomastoid and superficial tissues completes the operation.

The anterior approach carries with it little shock (we have had no deaths in ninety-nine operations) and patients frequently leave the hospital on the second day. Horner's syndrome is usually observed following trunkotomy or ganglionectomy. The drooping of the eyelid gradually disappears except when the patient is fatigued. The clearing process may go on for two years.

The operation is easier in children than in adults, and the operative time varies from forty minutes in childhood to as much as two and one-half hours in a short-necked adult. One thing more than any other facilitating either operation is adequate lighting. We have used all varieties of lights, but the only one that is satisfactory is the Scialytic spot light. It is best to shut out cross lights, which are extremely confusing.

We feel that the technic of operations on the sympathetic nervous system is well established. We feel on the other hand that we are but standing on the borderland of possibilities so far as the indications for operation are concerned.

BIBLIOGRAPHY

- ¹ Adson, A. W., and Brown, C. E.: The Treatment of Raynaud's Disease by Resection of the Upper Thoracic and Lumbar Sympathetic Ganglia and Trunks. *Surg., Gynec., and Obst.*, vol. xlviii, pp. 577-603, 1929.

SURGERY OF THE SYMPATHETIC

- ² *Idem*: Raynaud's Disease of the Upper Extremities; Successful Treatment by Resection of the Sympathetic, Cervicothoracic and Second Thoracic Ganglions and the Intervening Trunk. Jour. Am. Med. Assn., vol. xcii, pp. 444-449, 1929.
- ³ Henry, A. K.: Exposure of Long Bones and Other Surgical Methods. Wm. Wood, New York, 1927.
- ⁴ Kuntz, A.: Autonomic Nervous System. Lea & Febiger, Philadelphia, 1929.
- ⁵ Orbeli, L. A.: Hertzstein Lectures, 1929. Unpublished.
- ⁶ Royle, N. D.: The Treatment of Spastic Paralysis by Sympathetic Ramisection. Surg., Gynec., and Obst., vol. xxxix, pp. 701-720, 1924.
- ⁷ *Idem*: Sympathetic Trunk Section; a New Operation for Raynaud's Disease and Spastic Paralysis of the Upper Limbs. Med. Jour. Australia, vol. ii, pp. 436-438, 1928.
- ⁸ *Idem*: Personal Communication.

THE SURGICAL ASPECTS OF THE AUTONOMIC NERVOUS SYSTEM

BY WALTER D. ABBOTT, M.D.

OF DES MOINES, IOWA

IT IS the purpose of this paper to present the surgical aspects of the autonomic nervous system from a clinical viewpoint.

Historical.—Jonesco,^{29, 30} 1896, divided the trunk above and below the middle cervical sympathetic ganglion for epilepsy, and a year later he repeated this operation for exophthalmic goitre. Then, in 1899, Alexander⁷ removed both superior cervical sympathetic ganglia for epilepsy. However, little of note was accomplished until Jaboulay,²⁸ 1899, and Higier,²⁵ 1901, recommended tearing the nerve plexus around the femoral artery in cases of intermittent claudication. Leriche,^{39, 40} who established periarterial sympathectomy, reported two cases of causalgia in which benefit was obtained by resection of the sheath of the brachial artery in 1917. Since that time Leriche^{39, 40} has reported a large series of cases in which resection of the sheath of the artery relieved the vasoconstriction in such cases as Raynaud's disease, causalgia, trophic ulcers and the superinduced spasm of the collateral vessels in thrombo-angiitis obliterans.

However, the observations of Kramer and Todd³³ and Potts⁴² and Kuntz³⁵ demonstrated that the operation of periarterial sympathectomy was anatomically unsound because the sympathetic innervation of the peripheral vessels corresponds to the segmental musculocutaneous distribution of the spinal nerves.

In 1924, Hunter²⁷ and Royle,⁴⁷ endeavoring to relieve spastic paraplegia by ramisection, noted a post-operative increase in the temperature of the extremities, and a short time later Adson³ and Brown^{9, 10, 11} reported the first cases of Raynaud's disease in which lumbar sympathetic ganglionectomy and ramisection was performed with gratifying results. Subsequent observation of these cases for the past eight years demonstrates that the lower extremities have remained warm, dry and pink. Adson⁴ prefers the anterior approach in order to sever all the inconstant rami in front of the vertebral column which might be missed by the posterior route.

The anterior approach to the inferior cervical and first thoracic sympathetic ganglia met with failure more often than success, and until the posterior approach was devised by Henry,²⁴ 1924, and Adson,⁵ 1928, little was accomplished in the treatment of peripheral vascular diseases of the upper extremities. Since that time, many important contributions have clearly indicated the therapeutic value of sympathetic ganglionectomy in carefully selected cases of peripheral vascular disease.

In addition to the brilliant results achieved in vascular conditions, an

equally important chapter has been written in efforts directed toward relief of intractable pain. During the past decade, the contributions of Swetlow,⁵³ White^{56, 57} and Mixter⁴¹ in reference to relief of the pain of angina pectoris have been outstanding. These procedures consist of either alcoholic injection or removal of the sympathetic ganglia. Also, the work of Archibald⁸ and Scrimger⁵⁰ and Verbrugge¹³ and von Bogaert¹³ in alleviating abdominal pain and Stern's⁵² success in relieving the distress of thrombo-angiitis obliterans have been of value. In 1927, Rowntree⁴⁶ and Adson, and Henderson²³ and Adson,⁴⁶ 1932, described a series of cases of arthritis in which benefit was obtained by sympathetic ganglionectomy. Flothow,^{17, 18} 1931, and Abbott,^{1, 2} 1932, reported cases of intractable pain in various regions of the body which were relieved by alcoholic injection of the sympathetic ganglia.

PERIPHERAL VASCULAR DISEASE.—(A) Vasospastic Conditions.—*Raynaud's Disease.*—This is the most classical vasospastic condition to be seen in any type of vascular lesion. The disease is characterized by bilateral vasoconstriction of the hands and feet. Little has been added to Raynaud's⁴⁵ original description when he observed a form of gangrene of the extremities without any evidence of vascular occlusion.

This phenomenon is seen chiefly in women. Few cases of pure vasoconstriction are observed in men without some evidence of vascular occlusion. The symptoms vary in degree to such an extent that many cases of mild vasoconstriction are erroneously diagnosed as a true Raynaud's disease. These patients present a coldness of the hands and feet, some blanching of one or more digits and a moderate amount of pain when exposed to the cold weather. Relief may be obtained by the application of heat and warmer clothes so that a surgical procedure is unwarranted. However, a true Raynaud's disease is characterized by the presence of symmetric color changes in the extremities varying from blanching to a deep cyanosis, clammy and cold extremities. There is intense pain from the vasospasm which is provoked by exposure to the cold or emotional influences. The gangrene of Raynaud's disease begins as a small trophic ulcer at the tip of the finger or toe and is associated with a distortion of the growth of the nails.

Sympathetic ganglionectomy and ramisection will provide maximum dilatation of the vessels and immediately after operation the extremities are warm, dry, pink and free from pain. The removal of the inferior cervical and upper two dorsal sympathetic ganglia for relief of vasospasm in the upper extremity is attended with a Horner's syndrome, but when the operation is performed on both sides, this sequela is hardly noticeable. This syndrome consists of a narrowing of the palpebral fissure, a constriction of the pupil, and absence of perspiration over the face. There is also a dilatation of the retinal veins and increase in the calibre of the arteries of the nasal mucosa followed by an increased secretion. This slight discomfort seems negligible in comparison to the severe pain in the extremities and danger of gangrene. It is obvious that all cases of vasoconstriction should be carefully

selected for surgery so that there will be full assurance of obtaining a maximum blood supply by removing the sympathetic ganglia.

Causalgia is a painful condition following trauma to the peripheral nerves, chiefly the ulnar, median and sciatic nerves. There is a complaint of constant pain, and the skin is glossy, red or mottled red and white. Joint and muscle action seems limited, apparently because of the intense pain. A number of cases have been reported in which sympathetic ganglionectomy or alcoholic injection of the ganglia have afforded relief; however, this type of case must be selected with utmost care because of the psychic and compensation element.

Scleroderma is a disease of the skin characterized by pigmentation, thickening or atrophy, and is frequently associated with sclerodactylia. Although there are several forms of this disease, the one group giving a previous history of cold, clammy, cyanotic extremities is amenable to surgical intervention. Sympathetic ganglionectomy increases the blood supply to the affected extremity, and there is a subsequent loosening of tight skin.

Arthritis.—In treating arthritis, an attempt is made to obtain maximum blood supply to the joint involved. In a small group of cases, a history of cold, clammy, cyanotic extremities is significant and, provided temporary vasodilatation produces relief, the removal of the sympathetic ganglia is of distinct benefit. However, there is no group of cases in which deliberate judgment is required any more than in the arthritic patients, who are possible candidates for surgical intervention.

(B) Vaso-occlusive Conditions.—*Thrombo-angiitis obliterans* is a disease of the blood-vessels characterized by arterial occlusion, varying degrees of color changes in the extremities, pain and extensive gangrene. Buerger's original description stated that this condition occurred only in Hebrews, and that cigarette smoking was a definite contributing factor. However, subsequent observations have demonstrated that no race is immune and, although immoderate use of tobacco will produce a vasoconstriction, this condition is seen also in non-smokers. There is a predominance in the male sex, but recently a number of cases of women have been reported. The course of this disease is slow, and for some time may be manifested only by coldness and cyanosis of the extremities. A little later there is definite blanching of the digits upon exposure to the cold, and if the occlusion is present in the lower extremities, there will be intermittent claudication on walking. Following these symptoms, color changes appear, varying from a deep rubor to a marked cyanosis which is replaced by blanching when the extremity is elevated. Gangrene appears in two ways, either as a trophic ulcer which rapidly assumes serious proportions, or around the base of the nail and involves all or part of one digit. Examination reveals diminution or absence of pulsations in the arteries of the extremities, and unless adequate collateral circulation can be obtained, amputation is imminent.

It is obvious that nothing can be accomplished with the occluded vessel, but the superinduced spasm of the collateral vessels can be relieved by sever-

ing the vasoconstrictor fibres, so that by dilatation of these vessels an increase of blood volume will be produced and relief of pain will be achieved. Often, it is preferable to administer hypertonic saline intravenously before resorting to surgery, because through the principle of osmosis an increase in blood volume is attained. It is to this end that removal of the sympathetic ganglia is directed, but the utmost care must be exerted in the selection of cases for this procedure is a major operation and there must be sufficient assurance that sympathectomy will produce an adequate increase in blood supply.

Arterial sclerosis is an unwelcome companion of senescence, and although there is little chance of dilating brittle arteries, relief from intractable pain and provision for maximum blood supply can be obtained. In these patients, alcoholic injection of the sympathetic ganglia is the procedure of choice for it carries practically no risk in skilled hands and the relief from pain is preferable to massive doses of narcotics. It is not infrequent that there still remains an element of vasoconstriction and it is gratifying to see an ulcer heal or an amputation at a lower level following alcohol block.

SELECTION OF CASES.—The success of sympathetic ganglionectomy in the treatment of peripheral vascular conditions is dependent upon the careful selection of cases and the thorough interruption of all of the vasoconstrictor fibres. There are four methods of determining the degree of vasospasm and to what extent an increase in blood supply can be anticipated after ganglionectomy. These tests remove all elements of chance and are founded upon sound physiological principles.

(1) The "fever" test was devised by Adson and Brown,⁶ 1925, and consists of the administration of typhoid vaccine intravenously and estimating the degree of rise in the surface temperature of the extremities in contrast to the rise in mouth temperature. This is an accurate test of relative blood flow to an extremity, and with the sympathetic fibres temporarily paralyzed, an accurate estimation of the vasoconstrictor element is obtained. It is necessary to use an electrothermocouple in these tests, and when a sufficient rise in surface temperature is manifested, it is an indication that sympathetic ganglionectomy will be of value.

The objection to the fever test is that it produces a severe generalized reaction and gives no information relative to pain relief.

(2) Spinal anæsthesia will produce vasodilatation, but this method is satisfactory for only the lower extremities and is impractical because it gives no information relative to relief of pain.

(3) Direct injection of the nerve trunks is of value because estimation as to pain relief is obtained in addition to the degree of rise in surface temperature. Scott⁵¹ and Morton⁵¹ have established this simple test and by this procedure can gauge accurately the amount of arterial spasm. The only danger in this method is in the doubt of interrupting all of the vasoconstrictor fibres to a given point.

(4) Direct injection of the sympathetic ganglia, as advocated by

White,^{56, 57} produces a selective and discriminative result as both vasodilatation and pain relief are obtained in as large or limited an area as desired.

RELIEF OF PAIN.—*Pain of the head and neck.*—The reports of Mixter⁴¹ and White⁴¹ indicate that some of the pain fibres from the head and neck pass through the inferior cervical and first thoracic sympathetic ganglia before entering the spinal cord. This view is supported by Flothow's^{17, 18} case, in which removal of the inferior cervical and first thoracic sympathetic ganglia provided relief from severe facial neuralgia after section of the posterior sensory root had failed, and Abbott's case in which alcoholic injection produced a similar result. However, Frazier's²¹ results were unsatisfactory, but if the posterior approach had been used, the pain fibres might have been interrupted more completely. Recently, Dandy¹⁵ has removed the inferior cervical and first two thoracic sympathetic ganglia in two cases of hemicrania with satisfactory results over a period of many months. It is unquestionable but that pain of the head and neck can be relieved by obliteration of the inferior cervical and upper two thoracic sympathetic ganglia when other methods have failed.

Thoracic Pain.—The most common type of pain in the chest is angina pectoris, and yet it is generally agreed that there are a number of types of this pain. In 1899, Franck²⁰ suggested that pain fibres from the heart traversed the thoracic sympathetic ganglia, and thirty years later, his contention was corroborated by Ranson⁴⁴ and Kuntz.³⁵ Although it is obvious that any surgical procedure in angina pectoris is only palliative, relief of pain is often a paramount factor in the course of the disease. Numerous operations have been proposed from removal of the superior cervical sympathetic ganglion down to and including the fifth thoracic ganglion. Such major procedures upon a patient with a poorly functioning cardiac mechanism seem unwarranted when the afferent visceral fibres can be so easily interrupted by injection. This was first demonstrated by Brunn¹² and Mandl,¹² 1924, who utilized paravertebral block with procain, and Swetlow,⁵³ 1926, who added alcohol in the injections. Since then, a number of gratifying reports have appeared in the literature, and, at present, the technic of White^{56, 57} seems most satisfactory. This consists of injection of the upper five thoracic sympathetic ganglia with 85 per cent. alcohol. Stress must be laid upon the careful selection of cases, for it is only in the cases where there seems to be evidence of vasospasm that this procedure is indicated.

In addition, other types of thoracic pain, such as thoracic crisis, have been relieved by either ramisection or ganglionectomy.

Abdominal Pain.—Every surgeon is at some time or other confronted with the problem of the patient with severe abdominal pain which has failed to respond to the usual series of operations upon the stomach, gall-bladder, appendix and pelvic organs. No doubt but there are certain types of neurogenical pain which can be relieved only by interruption of the visceral afferent fibres. This can be accomplished by either ganglionectomy or injection as

indicated in the reports of Archibald,⁸ Scrimger,⁵⁹ von Bogaert and Verbrugge,¹³ von Gaza,²² Woodbridge⁵⁸ and Abbott.^{1, 2}

It is now definitely established that lumbar sympathetic ganglionectomy will relieve the dilatation of the colon in Hirschsprung's disease following the work of Wade and Royle,⁵⁵ Adson and Judd,³¹ and Learmonth³⁶ and Rankin.⁴³

The contributions of Leriche,³⁸ Havelaque,²⁶ Fontaine and Herman¹⁹ have been of definite value in providing comfort to patients suffering from intractable pain in the pelvis of unknown origin. In addition, the work of Learmonth,³⁷ in alleviating the distress of cord bladder and certain bladder conditions by removal of the hypogastric plexus has been an epoch-making achievement. However, as in all cases under consideration for sympathetic ganglionectomy, extreme care must be exerted in the selection of each individual case.

Spastic Paralysis.—Sympathetic ganglionectomy and ramisection in spastic paralysis is directed toward release of the plastic component of the tonus of skeletal muscles and was advocated by Royle^{48, 49} and Hunter. This procedure was not proposed as a cure for spastic paralysis, but, according to Royle, "it merely removes a factor which has been interfering with the normal physical education of the individual, and the essential treatment of spastic paralysis is education of the central nervous system."

Royle has achieved some definite benefit by ganglionectomy as also have Carrell¹⁴ and von Lackum.⁵⁴ However, Kanavel,³² Pollack³² and Davis¹⁶ found this operation to be of no appreciable value in spastic paralysis from a number of causes.

More recently, Royle advocates thoracic ganglionectomy in lieu of removing the lumbar ganglia, and states as his reason that a vasodilatation of one-half of the cerebrum is achieved which reduces tone in the contralateral extremities. Thus it seems that no definite opinion can be voiced at present as the reports are too conflicting to speak finally without further research.

SURGICAL PROCEDURES.—*Periarterial sympathectomy* consists of removing the adventitia of the artery over a distance of two or three inches. This operative procedure is mentioned only to be condemned as anatomically and physiologically unsound.

Cervico-thoracic sympathetic ganglionectomy is performed by making a mid-line incision from the tip of the spinous process of the fifth cervical vertebra to the fourth dorsal vertebra. Then the tendinous attachments of the trapezius, rhomboid and posterior serratus muscles are severed and these muscles are retracted laterally. This leaves the erector spinæ and lower end of the splenius capitis muscles exposed and a blunt dissection will remove the periosteum over the first thoracic vertebra and rib for a distance of three centimetres. After resecting this area of the rib, with the transverse process of the first thoracic vertebra, the lung and pleura are retracted laterally and the sympathetic trunk is exposed. The inferior cervical, first and second thoracic sympathetic ganglia with their rami are then removed.

Lumbar sympathetic ganglionectomy is accomplished by making a mid-line abdominal incision, packing the intestines away and incising the posterior peritoneum from the promontory of the sacrum up over the aorta for a distance of fifteen centimetres. The psoas muscle is retracted laterally and the lumbar sympathetic ganglia with their rami are removed from the second to fourth, inclusive, on both sides.

Alcoholic injection of the sympathetic ganglia is performed by placing the patient in the prone position and inserting needles 2.5 centimetres lateral to the spinous process of the vertebra corresponding to the ganglion to be injected. The needle is directed down until the transverse process of the vertebra is felt and then inserted 2.5 centimetres below this point. Five cubic centimetres of 1 per cent. procain are injected, followed by four cubic centimetres of 95 per cent. alcohol. It is not uncommon for neuritic pains to follow an injection of this type, but these are controlled by salicylates and disappear in two or three weeks.

SUMMARY.—The surgical aspects of the autonomic nervous system are founded upon the physiological principles of local asphyxia or conduction of afferent visceral pain impulses. A review of the various conditions is presented in the hopes that it will stimulate further research into a relatively unexplored field and perhaps solve many perplexing problems. It is essential, however, to stress the careful selection of cases so that the brilliant results of the past will not be thrown into disrepute by attempts to combat disease by procedures not based on sound fundamental principles.

BIBLIOGRAPHY

- ¹ Abbott, W. D.: Diagnostic and Therapeutic Injection of the Sympathetic Nervous System. *Neb. St. Med. Jour.*, vol. xvii, p. 293, July, 1932.
- ² Abbott, W. D.: Relief of Intractable Pain by Nerve Block and Section. *Mo. St. Med. Jour.*, p. 379, August, 1932.
- ³ Adson, A. W., and Brown, G. E.: Treatment of Raynaud's Disease by Lumbar Ramisection and Ganglionectomy and Perivascular Neurectomy of the Common Iliac. *Jour. Am. Med. Assn.*, vol. lxxxiv, pp. 1908-1910, June, 1925.
- ⁴ Adson, A. W.: Surgical Relief of Raynaud's Disease and Other Vascular Disturbances by Sympathetic Ganglionectomy and Perivascular Neurectomy. *Ann. Clin. Med.*, vol. v, pp. 161-167, August, 1926.
- ⁵ Adson, A. W., and Brown, G. E.: Raynaud's Disease of the Upper Extremities. Successful Treatment by Resection of the Sympathetic Cervico-thoracic and Second Thoracic Ganglions and the Intervening Trunk. *Jour. Am. Med. Assn.*, vol. xcii, pp. 444-449, February, 1929.
- ⁶ Adson, A. W., and Brown, G. E.: The Treatment of Raynaud's Disease by Resection of the Upper Thoracic and Lumbar Sympathetic Ganglia and Trunks. *Surg., Gynec., and Obst.*, vol. xlviii, pp. 577-603, April, 1929.
- ⁷ Alexander: Quoted by Kuntz, 1899.
- ⁸ Archibald, E.: Effect of Sympathectomy for Obscure Pain. *Jour. Am. Med. and Surg. Assn.*, vol. xlvi, p. 179, 1928.
- ⁹ Brown, G. E.: The Skin Capillaries in Raynaud's Disease. *Arch. Int. Med.*, vol. xxxv, pp. 56-73, January, 1925.
- ¹⁰ Brown, G. E., and Adson, A. W.: Calorimetric Studies of the Extremities Following Lumbar Sympathetic Ramisection and Ganglionectomy. *Am. Jour. Med. Sci.*, vol. clxx, pp. 232-240, 1925.

SURGERY SYMPATHETIC SYSTEM

- ¹¹ Brown, G. E., and Allen, E. V.: Thrombo-angiitis Obliterans. A Clinical Study of 200 Cases: (1) Treatment and Prognosis. *Ann. Int. Med.*, vol. i, pp. 550-557, 1928.
- ¹² Brunn, F., and Mandl, F.: Die paravertebrale injektion zur Bekämpfung visceraler Schmerzen. *Wien. klin. Wchnschr.*, vol. xxxvii, p. 511, May, 1924.
- ¹³ von Gogaert, and Verbrugge, J.: Pathogenesis and Treatment of Gastric Crises of Tabes by Neuroramisectomy. *Surg., Gynec., and Obst.*, vol. xlvii, p. 543, 1928.
- ¹⁴ Carrell, W. B.: Sympathetic Ramisection in Spastic Paralysis: End-Results in Sixty Cases. *Jour. Am. Med. Assn.*, vol. xcvi, pp. 849-852, March 14, 1931.
- ¹⁵ Dandy, W. E.: Treatment of Hemisecrania (Migraine) by Removal of Inferior Cervical and First Thoracic Sympathetic Ganglia. *Bull. Johns Hopkins Hosp.*, vol. xlviii, pp. 357-361, June, 1931.
- ¹⁶ Davis, L., and Kanavel, A. B.: The Effect of Sympathectomy on Spastic Paralysis of the Extremities. *Jour. Am. Med. Assn.*, vol. lxxxviii, pp. 1890-1893, 1926.
- ¹⁷ Flothow, P. G.: Surgery of the Sympathetic Nervous System. A Report of Fourteen Sympathetic Ganglionectomies. *Am. Jour. Surg.*, vol. x, pp. 8-18, 1929.
- ¹⁸ Flothow, P. G.: Diagnostic and Therapeutic Injection of the Sympathetic Nerves. *Am. Jour. Surg.*, vol. xiv, pp. 591-604, 1931.
- ¹⁹ Fontaine, R., and Herrman, L. G.: Clinical and Experimental Basis for Section of the Pelvic Sympathetic Nerves in Gynecology. *Surg., Gynec., and Obst.*, vol. xlv, pp. 133-163, 1932.
- ²⁰ Franck: Quoted by Kuntz.
- ²¹ Frazier, C. H.: A Typical Neuralgia. Unsuccessful Attempts to Relieve Patients by Operations on the Cervical Sympathetic System. *Arch. Neurol. and Psychiat.*, vol. xix, p. 650, April, 1928.
- ²² von Gaza, W.: Die Resektion der paravertebralen Nerven und die isolierte Durchschneidung des Ramus communicans. *Arch. f. klin. Chir.*, vol. cxxxiii, p. 429, 1924.
- ²³ Henderson, M. S., and Adson, A. W.: Sympathetic Ganglionectomy and Trunk Resection in Arthritis. Indications and Results. *Jour. Bone and Joint Surg.*, vol. xiv, pp. 47-56, 1932.
- ²⁴ Henry, A. K.: A New Method of Resecting the Left Cervico-thoracic Ganglion of the Sympathetic in Angina Pectoris. *Irish. Jour. Med. Sci.*, vol. v, pp. 157-167, 1924.
- ²⁵ Higier: Quoted by Kuntz.²⁶
- ²⁶ Havelacque, A.: Anatomie des nerfs craniens et rachidiens et du systeme grand sympathique. *Pars. Dain* 1927.
- ²⁷ Hunter, J. I.: The Influence of the Sympathetic Nervous System in the Genesis of the Rigidity of Striated Muscle in Spastic Paralysis. *Surg., Gynec., and Obst.*, vol. xxxix, pp. 723-743, 1924.
- ²⁸ Jaboulay: Quoted by Leriche. 1899.
- ²⁹ Jonesco, T.: *Zentralbl. f. chir.*, 1897.
- ³⁰ Jonesco, T.: Treatment Chirurgical de L' angine de Poitrine par la Resection du sympathique cervico thorasique. *Presse Med.*, vol. i, pp. 193-194, 1921.
- ³¹ Judd, E. S., and Adson, A. W.: Lumbar Sympathetic Ganglionectomy and Ramisection for Congenital Idiopathic Dilatation of the Colon. *Am. Jour. Surg.*, September, 1928.
- ³² Kanavel, A. B., Pollock, L. J., and Davis, L. E.: Experimental and Clinical Experiences with Sympathectomy in Spastic Paralysis. *Jour. Nerv. and Ment. Dis.*, vol. lx, pp. 590-594.
- ³³ Kramer, J. G., and Todd, T. W.: The Distribution of Nerves to Arteries of Arms with Discussion of Clinical Value of Results. *Anal. Rec.*, vol. viii, pp. 243-254, 1914.
- ³⁴ Kuntz, A.: Distribution of Sympathetic Rami to the Brachial Plexus. *Arch. Surg.*, vol. xv, pp. 871-877, 1927.
- ³⁵ Kuntz, A.: *Autonomic Nervous System*. Lea and Febiger, Philadelphia, 1929.

- ³⁰ Learmonth, J. R., and Braasch, W. F.: Resection of the Presacral Nerve in the Treatment of Cord Bladder. *Surg., Gynec., and Obst.*, vol. xli, pp. 501-504, 1930.
- ³⁷ Learmonth, J. R.: Neurosurgery in the Treatment of Diseases of the Bladder. *Jour. Urol.*, vol. xxv, p. 531, 1931.
- ³⁸ Leriche, R., and Heitz, J.: Resultats de la Sympathectomie periarterielle dans la traitement des troubles nerveux post-traumatiques d'ordre reflex. *Lyon chir.*, vol. xiv, pp. 754-792, 1917.
- ³⁹ Leriche, R., and Fontaine, R.: Experimental and Clinical Contribution to the Question on the Innervation of the Blood-vessels. *Surg., Gynec., and Obst.*, vol. xlvii, pp. 631-643, 1928.
- ⁴⁰ Leriche, R., and Strecker, P.: Researches experimentales sue le merf presacre. *Bull. et mem. Soc. nat. de chir.*, vol. liii, p. 819, 1927.
- ⁴¹ Mixter, W. J., and White, J. C.: Pain Pathways in the Sympathetic Nervous System. *Arch. Neurol. and Psychiat.*, vol. xxv, p. 986, May, 1931.
- ⁴² Potts, L. W.: The Distribution of Nerves to the Arteries of the Legs. *Anat. Anz.*, vol. xlvii, pp. 138-143, 1914-1915.
- ⁴³ Rankin, F. W., and Learmonth, J. R.: Section of the Sympathetic Nerves of the Distal Part of the Colon and the Rectum in the Treatment of Hirschsprung's Disease and Certain Types of Constipation. *Ann. Surg.*, vol. xcii, pp. 710-720, 1930.
- ⁴⁴ Ranisom, F. W.: Anatomy of the Sympathetic Nervous System with Reference to Sympathectomy and Ramisection. *Jour. Am. Med. Assn.*, vol. lxxxvi, pp. 1886-1890, 1926.
- ⁴⁵ Raynaud, M.: Local Asphyxia. *London New Sydenham Soc.*, vol. i, p. 150, 1888.
- ⁴⁶ Rowntree, L. G., and Adson, A. W.: Bilateral Lumbar and Thoracic Sympathetic Ganglionectomy and Ramisection for Polyarthritis of the Lower Extremities. *Jour. Am. Med. Assn.*, vol. lxxxviii, p. 694, 1927.
- ⁴⁷ Royle, N. D.: A New Operative Procedure in the Treatment of Spastic Paralysis and Its Experimental Basis. *Med. Jour. Australia*, vol. lxxvii, 1924.
- ⁴⁸ Royle, N. D.: The Treatment of Congenital Spastic Paraplegia by Sympathetic Ramisection. *Med. Jour. Australia*, vol. i, p. 31, April 30, 1927.
- ⁴⁹ Royle, N. D.: Alteration of the Circulation of the Brain by Surgical Means in Diseases of the Central Nervous System. *British Med. Jour.*, June 11, 1932.
- ⁵⁰ Scrimger, F. A. C.: On the Possibility of Relieving Abdominal Pain by Section of the Sympathetic Rami Communicanti. *Canad. Med. Assn. Jour.*, vol. xxi, p. 184, 1929.
- ⁵¹ Scott, W. J. Merle, and Morton, John J.: Sympathetic Activity in Certain Diseases, Especially Those of the Peripheral Circulation. *Arch. Int. Med.*, vol. xlviii, p. 1065, December, 1931.
- ⁵² Stern, E. L.: Alcohol Injection of Nerve Roots for Thrombo-angiitis Obliterans. *Am. Jour. Surg.*, vol. x, p. 107, 1930.
- ⁵³ Swetlow, G. J.: Paravertebral Alcohol Block in Cardiac Pain. *Am. Heart Jour.*, vol. i, p. 397, 1926.
- ⁵⁴ von Lackum, H. L.: Sympathetic Ramisection in Spastic Paralysis. *Jour. Am. Med. Assn.*, vol. xcii, pp. 139-143, 1929.
- ⁵⁵ Wade, R. B., and Royle, N. D.: Operative Treatment of Hirschsprung's Disease. New Method, with Explanation of the Technic and Results. *British Med. Jour.*, vol. i, p. 809, 1924.
- ⁵⁶ White, J. C.: Diagnostic Blocking of the Sympathetic Nerves to the Extremities with Procaine. *Jour. Am. Med. Assn.*, vol. xciv, p. 1382, May, 1930.
- ⁵⁷ White, J. C.: Angina Pectoris: Relief from Pain by Paravertebral Alcohol Block of Upper Dorsal Sympathetic Rami. In: *Vegetative Nervous System. Collected Papers Research on Nervous and Mental Disease.* Baltimore, Williams and Wilkins Co., vol. ix, pp. 786-891, 1930.
- ⁵⁸ Woodbridge, P. D.: Therapeutic Nerve Block with Procaine and Alcohol. *Am. Jour. Surg.*, vol. ix, p. 278, 1930.

INTERMITTENT CLAUDICATION WITHOUT GANGRENE CONTROLLED BY SYMPATHETIC NERVE BLOCK

BY FREDERICK LEET REICHERT, M.D.

OF SAN FRANCISCO, CALIF.

FROM THE DEPARTMENT OF SURGERY OF THE STANFORD UNIVERSITY MEDICAL SCHOOL

AMELIORATION of the distressing and frequently incapacitating intermittent claudication that appears in the arteriosclerotic individual may be effected by interruption of the sympathetic control of the arteries to the involved extremities. The degree of relief varies greatly, but may be accurately determined by diagnostic interruption of the lumbar sympathetic chain with novocaine. Other tests such as typhoid vaccine, spinal anaesthesia or peripheral nerve block which are excellent for determining the thermal response are quite unsatisfactory in measuring relief of pain. Furthermore, relief from pain may often be secured by sympathetic interruption even in the absence of an appreciable rise in dermal temperature.

Flothow's report¹ in 1931 on the sympathetic alcoholic injection for the relief of arteriosclerotic pain and gangrene at once stimulated a renewed effort to bring some relief to these unfortunates who reappeared in the clinic at intervals but who previously had received little if any help. For several years relief of pain in Raynaud's disease, thrombo-angiitis obliterans, scleroderma and certain cases of arthritis with obvious vasomotor instability has been effected in the Stanford clinic by interruption of the sympathetic pathways. Following Flothow's paper the procedure has also been applied in over twenty-five elderly people suffering with claudication. As a measure of its success it may be said that they are a group of most grateful patients.

Present knowledge indicates that sympathetic nerves to an extremity accompany and are a part of the peripheral nerves. They emerge from the nerve trunks at intervals to innervate segmentally the walls of arteries and veins, sweat glands and hair follicles. Beside these efferent fibres there are certain afferent sympathetic nerves that convey pain and other sensations.

Interruption of the sympathetic nerves to an extremity produces certain obvious changes due to the release of the vasoconstrictor impulses.² The skin becomes warm and dry and the superficial veins are visibly dilated. Experimentally, if a hemisymphathecctomy is performed, arterial injection through the heart six weeks later with Hill's bismuth oxychloride mass, which visualizes the arterial system in röntgenograms, reveals not only a slight dilation of the main arteries of the sympathectomized side, but a definite enlargement of the arterioles as well, so that many more small vessels become visualized than on the control side. (Figs. 1 and 2.) In comparing the röntgenograms of injected amputated limbs from arteriosclerotics with those made when amputation was performed several weeks after a sympathetic block, the striking appearance of many small, minute arteries, especially in the region of the

foot and ankle, is in sharp contrast to their absence in the non-sympathectomized arteriosclerotic amputated extremity.

Earlier diagnostic measures employed to determine the degree of dys-

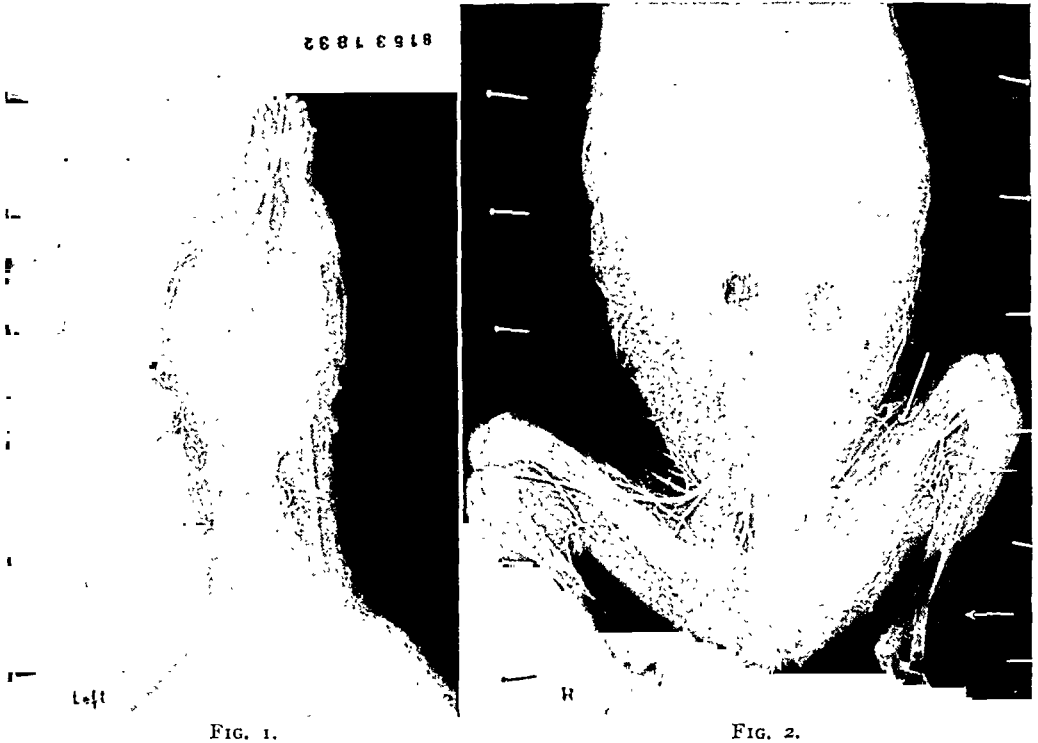


FIG. 1.

FIG. 2.

FIG. 1.—Hill's bismuth oxychloride mass injected through the heart into the arterial system of a dog six weeks after left hemisymphathectomy. There is slight dilatation of the main vessels and many more visual and enlarged arterioles on the sympathectomized side. Upper half of body.

FIG. 2.—Lower half of body of dog injected with Hill's arterial mass six weeks after left hemisymphathectomy. The slight enlargement of the main arterial trunks and the dilatation of the arterioles are especially evident in the left extremity.

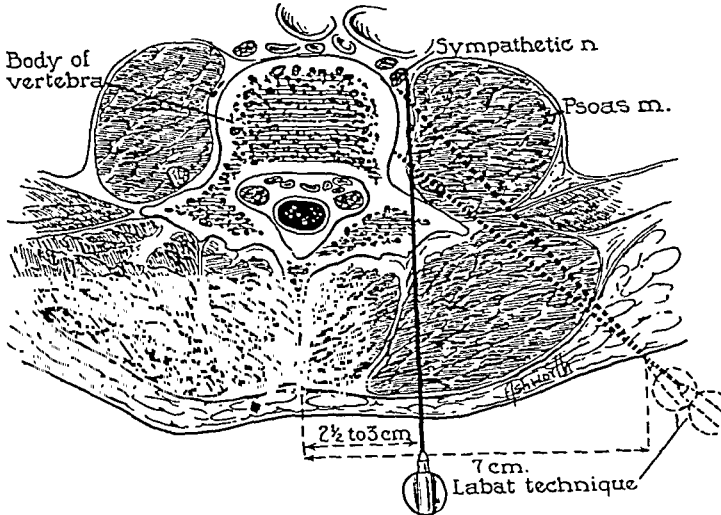


FIG. 3.—Illustrating Lundy and Labat technic for lumbar injection.
(From Flothow, Amer. Jour. Surg., Dec., 1931.)

function of this nervous system in the limb were mainly dependent upon the thermal changes induced by foreign protein, hot baths or spinal anæsthesia. Since it is the relief of pain for which these patients seek help, a test that

would indicate the degree of relief from pain obviously would be more satisfactory, particularly in the arteriosclerotic group where the thermal skin response may be insufficient to warrant any sympathetic interruption. The most satisfactory test for measuring alterations in pain (as well as securing the measurement of the thermal response in the skin), and one which will in a large measure permit the patient to be the judge, is the interruption of the autonomic impulses alone by the paravertebral novocaine injection of the sympathetic chain and ganglia as advocated by White.³ This injection does not interfere with any activity of the patient and when applied while the patient has pain or can induce pain serves as an exact criterion of the relief than can be secured either by operative removal or alcoholic injection of that portion of the sympathetic nervous system.

When the release of sympathetic impulses in a limb by novocaine has demonstrated a favorable influence on the symptom of pain the interruption in elderly people can be made permanent by the alcoholic injection of the sympathetic chain. In the majority of cases within two or three weeks after the injection of alcohol the increase in distance traversed before the onset of claudication has been double or triple that determined by the diagnostic test. The injection is performed in the same manner as for the diagnostic novocaine block and can be done in the ambulatory patient without any general anaesthesia. The greatest difficulty with the injection method is the accurate placing of the ends of the needles in approximation to the sympathetic chain. Using the method of Labat or the more recent modification of Lundy and described by Flothow,⁴ when the ends of the needles are close to the sympathetic chain the unanaesthetized patient, during the introduction of the first cubic centimetre of alcohol will complain of transient epigastric or abdominal pain. Failure to secure this upper abdominal pain is indicative that the needle points are not near the sympathetics and that they must be shifted to a more accurate position. The illustrations (Figs. 3 and 4) from Flothow's paper visualized the course of the needles. For the lower extremity three needles placed opposite the interspaces at lumbar 1, 2 and 3 are usually sufficient.

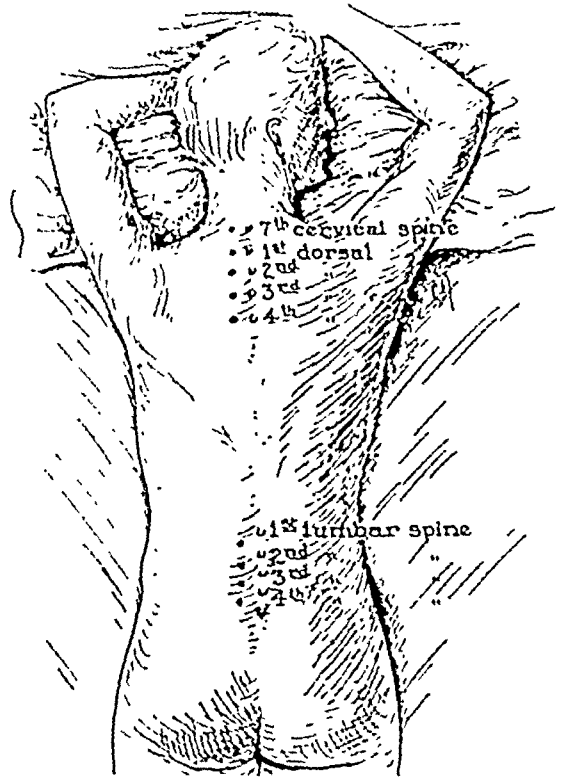


FIG. 4.—Point of insertion of needles for dorsal and lumbar injections using Lundy technique. First dorsal segment lying opposite the seventh cervical spine, showing that dorsal injection is made opposite spine and lumbar injection opposite interspaces. (Reproduced by permission from the Amer. Jour. Surgery, Dec., 1931.)

Theoretically, if the ganglia are destroyed by alcohol, the result should be as permanent as operative removal. Some of our patients have been relieved for a period of two years after one injection. Others have been reinjected one or more times before the block has become effectual. The diffusion of alcohol always produces peripheral neuralgia but it is less severe and not incapacitating when the block is made for the lower extremities.

The following case report illustrates the method and its application. An American caretaker, sixty-nine years old, first entered the Stanford Clinic in 1928 when a large epithelioma of the lower lip and the regional lymph-glands was excised. Metastases to the mandible were successfully treated by deep Röntgen-ray therapy two years later. Anacidity without known cause led the clinicians to maintain a continued interest in him.

In February, 1932, cramps in his calf muscles developed and became so severe that he was unable to walk even a city block before he was forced to stop and rest. Contrast baths to the lower limbs and graded exercises produced no appreciable improvement. The left heel became painful and the feet were damp and cold. Bed socks helped but even at night cramps would develop and force him to walk about his room.

In the dependent position his feet were reddish purple and blanched quickly on elevation. No pulsation could be felt in either posterior tibial or dorsalis pedis arteries.

May 9, 1932, as a diagnostic procedure, the lumbar sympathetic chain on both sides was blocked with novocaine. Previous to the block he could walk only five turns in the corridor before claudication developed. Immediately after the block he doubled this distance before pain appeared so that he was quite emphatic that the "serum" warmed his feet and enabled him to walk farther.

The bilateral interruption of the lumbar sympathetic chain was made permanent by alcoholic injection May 11th. As the first cubic centimetre of alcohol was injected he complained for several minutes of precordial and epigastric pain.

When he reported to the clinic, May 17th, he was able to walk fifteen city blocks before the onset of claudication, the left heel was no longer painful, and the pulsations of the left dorsalis pedis artery were faintly felt. He complained of neuralgic pains in his back and groin.

He was admitted to the medical service June 13th complaining of palpitation and shortness of breath. Chronic myocarditis with moderate myocardial insufficiency was diagnosed. It was learned that the relief from claudication had led him during the three days before admission to take long walks in the park and on the beach. This excessive exercise apparently precipitated the cardiac disturbance.

When seen October 1st, nearly five months after injection, he reported that he had been working all day since June without any discomfort in his feet, and although he felt a slight aching in the calves after walking two or three blocks, he could traverse six to eight blocks before the cramps stopped him. Neither coldness of his feet nor cramps bothered him at night. Both feet were warm and dry with many visible dilated veins. The right dorsalis pedis artery was easily palpable but pulsations were not definitely felt in the left foot.

One of the two women treated in this group of twenty-five patients with intermittent claudication had a hemiplegia six years before. Her cold, aching limb became warm, free of pain and permitted an increase in the distance walked to three or four blocks before the onset of cramps. The relief from cramps at night which had interfered with sleep is always commented upon by these patients. An increase of distance from one-quarter or one-half a city block to two, four or even ten blocks is a great asset to these people and frequently enables them to secure work. Several patients who have been

SYMPATHETIC NERVE BLOCK

previously helped by contrast baths and graded exercises obtained further improvement after sympathetic block. Since the dominant factor in the condition of these patients is circulatory, protection of the limb from cold must be continued even after sympathetic block.

Claudication is a symptom of a generalized pathological process. Relief of the local manifestations in the extremities can be given by sympathetic block. In time even the improvement from vasodilatation and the relief from pain are frequently not sufficient to prevent the advances of the pathological process and only amputation remains. Yet years of comfort and amelioration of the cramps in the lower limbs may be offered to some of the arteriosclerotic individuals by regional sympathetic nerve block.

SUMMARY

Relief of intermittent claudication in the arteriosclerotic individual may be secured by interruption of the sympathetic pathways with alcohol.

The usual tests to determine the efficiency of sympathetic interruption such as the thermal response in the skin to spinal anesthesia, foreign protein or peripheral nerve block are not applicable in determining the effect of such interruption on the pain of claudication. Relief of pain is not infrequently obtainable even in the absence of a rise in skin temperature. When the thermal response alone is the only criterion for or against sympathetic interruption, certain cases will be overlooked in whom sympathetic block will be of distinct benefit.

A satisfactory diagnostic procedure to determine the relief from pain is a paravertebral injection of the sympathetic chain with novocaine which enables the ambulatory patient to assist the physician in judging whether permanent interruption will be beneficial.

Twenty-five cases of intermittent claudication without gangrene have been materially and occasionally strikingly benefited by permanent interruption of the sympathetic chain by paravertebral injection of alcohol following the diagnostic use of novocaine.

BIBLIOGRAPHY

- ¹ Flothow, P. G.: Sympathetic Alcoholic Injection for the Relief of Arteriosclerotic Pain and Gangrene. *Northwest Med.*, vol. xxx, p. 408, 1931.
- ² Reichert, F. L.: Thermal Changes in Denervated and Sympathectomized Limbs with and without Arterial Ligation. *Proc. Exper. Biol. and Med.*, vol. xxix, p. 473, January, 1932.
- ³ White, J. C.: Diagnostic Blocking of Sympathetic Nerves to Extremities with Procaine. *Jour. Am. Med. Assn.*, vol. xciv, p. 1382, May 3, 1930.
- ⁴ Flothow, P. G.: Diagnostic and Therapeutic Injections of the Sympathetic Nerves. *Amer. Jour. Surg.*, vol. xiv, p. 591, 1931.

PHRENIC NEURECTOMY
RESULTS IN 100 CASES
BY RICHMOND DOUGLASS, M.D.
OF LOOMIS, N. Y.

FROM THE LOOMIS SANATORIUM FOR TUBERCULOSIS

PHRENIC neurectomy, or more briefly phrenicectomy, has been resorted to by phthysiologists with increasing frequency during recent years. The precise value and status of this operation in the group of intervention procedures used in pulmonary tuberculosis have not yet been determined. It may be used as an adjunct to therapeutic pneumothorax and to thoracoplasty, or it may be employed as an independent procedure.

The phrenic nerve is derived from the third, fourth and fifth cervical nerves, and runs downward, lying upon the anterior scalene muscle and crossing it diagonally from its lateral border. The nerve continues downward into the thorax, passing between the subclavian artery and vein. It is occasionally joined by accessory nerves, which rise from the fifth and sixth cervical nerves, and unite with the main nerve in the lower part of the neck or in the thorax. The interruption of these accessories is most surely accomplished by the evulsion of at least 10 centimetres of the phrenic nerve, and this fact has given phrenicectomy its place of major importance as the method of paralyzing the diaphragm. It is important to remember that anomalies of the phrenic nerve may be present. These have been described by Matson.¹

At Loomis Sanatorium the operation is performed under local anæsthesia after giving a preliminary hypodermic of morphine sulphate, gr. 1/6. The skin may be prepared with tincture of iodine or 5 per cent. alcoholic solution of picric acid. The patient lies on his back, without supporting pillows, and with his head turned away from the field of operation. The lateral border of the clavicular head of the sternomastoid muscle is located at a point 2 centimetres above the clavicle, and with this site as a mid-point the skin and subcutaneous tissues are infiltrated with 1 per cent. procaine parallel to the skin folds. In this line an incision 3 to 4 centimetres in length is carried through the skin, fascia and platysma, exposing the lateral border of the sternomastoid muscle. By blunt dissection the sternomastoid is freed and drawn mesially. At this point the anterior scalene muscle, which is recognized by its rounded contour, is located by palpation. The blunt dissection is then directed toward exposing the anterior scalene. The nerve is typically located under the fascial plane overlying the anterior scalene, but may be found along the lateral or medial border of the muscle. It is identified by gentle pinching which will cause a contraction of the diaphragm and pain which is usually referred to the anterior surface of the shoulder. The nerve is then grasped with a hemostat or with a phrenic evulsion forceps, and is cut and the lower end slowly withdrawn from the chest by winding upon the forceps. The fibres

of the nerve may rupture, or the entire nerve may be evulsed; one evulsed nerve in this series measured 40 centimetres in length. If undue tension is present and the requisite 10 centimetres has been freed, the nerve is cut to avoid injuring intrathoracic structures. Hemostasis is then cared for, the platysma approximated by two or three interrupted sutures of plain 00 catgut, and the skin closed without drainage by a subcuticular stitch. The actual evulsion is unavoidably attended by pain which may be very severe. Post-operative discomfort, however, is not marked. The operative technic has been described by Alexander,² Matson,¹ and others.

Crushing of the nerve may be done instead of evulsion. After identification the nerve is infiltrated with procaine. The lateral border of the anterior scalene muscle is then exposed as far downward as possible and any accessory trunks which are located are cut. The phrenic nerve is now crushed at one point by a Kelly hemostat. This procedure is almost entirely painless. The temporary paralysis of the diaphragm which results is of approximately six months' duration. Re-operation, if required, is not very difficult.

During the past four years the staff of Loomis Sanatorium has endeavored to apply and to evaluate phrenicectomy. A number of patients enter the sanatorium with extensive lesions or an obviously acute clinical course. It is the practice of the staff to institute therapeutic pneumothorax at once for all in this group if possible. Other patients show lesions whose estimated potentialities for healing are such as to warrant a period of bed rest and observation before a decision is made to use collapse therapy. The choice then lies between therapeutic pneumothorax and phrenicectomy, and may, if the pleura is adherent, necessarily be phrenicectomy. The operation has been advised after careful consideration of each case. In each patient the position of the diaphragm on inspiration and on expiration was recorded by X-ray films immediately before operation, two weeks after operation, and every thirty to sixty days thereafter. The patient's vital capacity was determined before and after paralysis of the diaphragm. The X-ray interpretations regarding presence or absence of cavity, thickness of cavity wall, position of cavity and type of surrounding infiltration were all made by the staff röntgenologist and may be regarded as uniform. The sputum was considered negative only when microscopical examination of smears of the concentrated sputum failed to reveal tubercle bacilli.* For purposes of formal classification the Standards of the National Tuberculosis Association have been used.

The success of any collapse procedure can be stated clearly only when the result to be attained has been defined. Technically a phrenicectomy is successful if the diaphragm is paralyzed. Superficially it may be regarded as benefiting the patient if there is a decrease in the size of the cavity and a

* The method employed by Dr. J. Stanley Woolley, Director of the Babbitt Memorial Laboratory, is as follows: Up to 1 ounce of sputum is treated with one volume of 1 per cent. NaOH, shaken and incubated over night. One volume of 0.4 per cent. H₂SO₄ (by volume) is then added and the mixture centrifuged. The sediment is stained for tubercle bacilli with Cooper's stain.

diminution in the amount of sputum. The Loomis staff, however, considers the procedure successful only when the X-ray film no longer reveals a cavity and the sputum is consistently negative for at least three successive months. In other words, only those patients discharged as arrested or apparently arrested are regarded as showing a successful result following this procedure.

The staff has withheld phrenicectomy in patients whose lesions might be expected to heal promptly on bed rest alone. The sacrifice of diaphragmatic function in cases with unilateral disease when bed rest may effect an early cure would seem to be unjustified. The paralyzed diaphragm may be a handicap in the future care of the patient, and there is as yet inadequate evidence as to the ultimate effect of the lost diaphragmatic function on respiration and circulation. Operation is also withheld if the lesion appears to be too extensive to be controlled by paralysis of the diaphragm. Widespread caseation, consolidation of a lobe, and large cavities replacing an entire lobe are regarded as contraindications, although exceptions may be made when it is impossible to induce pneumothorax to control hemoptysis. Extremely dense apical lesions are considered unfavorable. Phrenicectomy has been given in borderline cases where pneumothorax might otherwise have been administered. These cases are designated elective phrenicectomies. In such cases pneumothorax is given if the lung, after phrenicectomy, requires additional compression. The application of phrenicectomy, therefore, cannot be decided by adherence to any routine formula, but requires the judgment of clinicians experienced in tuberculosis.

Phrenicectomy, as a mechanical aid, supplements bed rest as a means of healing the lesions of pulmonary tuberculosis. The closure of cavities may be expedited by the operation, but the fundamental requirement of time for fibrous tissue development about the foci of disease cannot be ignored; therefore adequate post-operative sanatorium care is a requisite in all cases.

The mechanical effect of phrenicectomy is twofold. In the first place there is ascent of the paralyzed diaphragm with consequent relaxation of the lung parenchyma which permits elastic retraction of the diseased area. In this respect phrenicectomy has much the effect of a partial pneumothorax. The second effect is immobilization of the diaphragm which affords rest to the pulmonary tissues. The degree of rest afforded is not absolute since pulmonary ventilation is effected by a combination of diaphragmatic motion and excursion of the ribs. The part played by relaxation and by immobilization in the healing of tuberculous lesions is not constant and neither ascent of the diaphragm nor degree of immobilization can be used in establishing the prognosis for cavity closure.

The results in the 100 cases are shown in Table I. Ninety-eight of the cases included in this report received phrenicectomy; in two cases the phrenic nerve was crushed and the accessory nerve divided. As the diaphragm was paralyzed in these two patients they are considered with the phrenicectomies for the purposes of this paper. The 100 operations were performed between January, 1929, and July, 1932; thus there has been a period of observation of

PHRENIC NEURECTOMY

six months since the last operation. Ninety-two patients were operated upon at Loomis Sanatorium, eighty by the writer, twelve by other surgeons, while in the remaining eight the operation antedated admission.

Of the seventy-five cases in the pneumothorax failure and elective phrenicectomy groups, sixty had definite round or oval cavities; the remainder had honeycombed excavations. In twenty of the sixty cavities a fluid level was demonstrated by X-rays. All had tubercle bacilli in the sputum.

Of the eight patients receiving phrenicectomy before admission two were discharged as quiescent; of these, one has since had a thoracoplasty and is doing well, the other is running a chronic course. Two were discharged as

TABLE I
Results in 100 Phrenicectomies

| PHRENICECTOMY | Cases | Male | Female | Right | Left | Classification on Discharge | | | | | | |
|----------------------------|-------|------|--------|-------|------|---------------------------------|-----|----|----|---|---|-----------------|
| | | | | | | A | A A | Q | I | U | D | |
| PNEUMOTHORAX FAILURES | | | | | | | | | | | | |
| Moderately Advanced | 1 | 1 | - | 1 | - | - | 1 | - | - | - | - | |
| Far Advanced | 23 | 16 | 7 | 15 | 8 | 3 | 2 | 6 | 10 | 2 | - | |
| TOTAL | 24 | 17 | 7 | 16 | 8 | 3 | 3 | 6 | 10 | 2 | - | |
| ELECTIVE PHRENICECTOMY | | | | | | | | | | | | Given Pneumo |
| Moderately Advanced | 20 | 14 | 6 | 10 | 10 | 1 | 8 | 8 | 1 | - | - | 2 |
| Far Advanced | 18 | 12 | 6 | 9 | 9 | 5 | 1 | 4 | 1 | 1 | - | 6 |
| TOTAL | 38 | 26 | 12 | 19 | 19 | 6 | 9 | 12 | 2 | 1 | - | 8 |
| OPERATION BEFORE ADMISSION | 8 | 3 | 5 | 4 | 4 | - | - | 2 | 2 | 2 | 2 | |
| PRIOR TO REEXPANSION | 13 | 4 | 9 | 3 | 10 | Complete = 9 Incomplete = 4 | | | | | | |
| RELAXATION OF ADHESIONS | 2 | - | 2 | 1 | 1 | Successful = 1 Unsuccessful = 1 | | | | | | |
| PRIOR TO THORACOPLASTY | 2 | 1 | 1 | - | 2 | | | | | | | |
| OBSERVED UNDER 3 MONTHS | | | | | | | | | | | | |
| Pneumothorax Failures | 6 | 3 | 3 | 6 | - | | | | | | | |
| Elective Phrenicectomy | 7 | 4 | 3 | 4 | 3 | | | | | | | |
| TOTAL | 13 | 7 | 6 | 10 | 3 | | | | | | | |

improved; of these, one has had a thoracoplasty and is not doing well, the other has since received pneumothorax. Two were discharged as unimproved and have since died, and two patients died in the sanatorium. The admission of these patients to the sanatorium after phrenicectomy had been performed implies that their disease was progressive; consequently they comprise a group of cases having an unfavorable prognosis. Nevertheless, it is felt that these eight cases exemplify an injudicious application of phrenicectomy since in three patients the pulmonary excavation was extensive, the largest cavity measuring 8 by 14 centimetres; furthermore, in seven of the eight the infiltration about the cavities was dense and widespread. The average age of the group was thirty-seven years; the average cavity area was 21 square centimetres, and the surrounding infiltration was moderate to heavy. These findings are to be contrasted with those appearing in the first column of Table III.

Of the two patients receiving phrenicectomy as a preliminary to thoracoplasty, one died of spontaneous pneumothorax before thoracoplasty was performed, and the other refused thoracoplasty and continues under treatment. The staff does not routinely recommend phrenicectomy prior to thoracoplasty, believing that the operation contributes little to a satisfactory result, and that, on the contrary, it may even be detrimental since paralysis of the diaphragm may decrease the ability to expel secretions during the post-operative period.

Upon two patients who were receiving pneumothorax phrenicectomy was performed to relieve the tension of diaphragmatic adhesions. In one patient the desired result was not attained and a thoracoplasty was eventually performed. In the other patient pneumothorax had been maintained for three and a half months, but the cavity had remained patent despite three months of positive intrapleural pressures. Within three months after phrenicectomy the cavity had closed and the sputum had become negative on concentration.

Phrenicectomy was utilized in thirteen patients as a preliminary to reëxpansion of collapsed pneumothorax lung, since those patients whose lesions had

TABLE II

Results in 62 Cases of Phrenicectomy

Combining 24 Pneumothorax Failures and 38 Elective Phrenicectomies

| Cases | Arrested Cases | % | App.Arrested Cases | % | Quiescent Cases | % | Improved Cases | % | Unimproved Cases | % | Given Pneumothorax Cases | % |
|-------|-------------------|------|-----------------------|------|--------------------|------|-------------------|------|---------------------|-----|--------------------------------|------|
| 62 | 9 | 14.5 | 12 | 19.4 | 18 | 29.0 | 12 | 19.4 | 3 | 4.8 | 8 | 12.9 |

been large before pneumothorax may run a greater risk of exacerbation when pneumothorax is terminated. The elevation of the paralyzed diaphragm following phrenicectomy decreases the volume of the pleural space; hence less pulmonary reëxpansion is required. Reëxpansion is incomplete, as yet, in four cases; of the nine with reëxpansion complete, seven are well and working, one has had disease develop in a new area in the previously collapsed lung, and one who never had a consistently negative sputum has suffered an exacerbation.

Thirteen patients could not be followed for over three months after phrenicectomy and therefore their present status cannot be included as a part of this report.

Sixty-two patients have been followed for over three months after operation. Of these, twenty-four had adherent pleura precluding pneumothorax and are reported in the "pneumothorax failure" group, and thirty-eight received "elective phrenicectomy." The results in the sixty-two cases are shown in Table II.

The sixty-two cases summarized in this table are presented in detail in Table III. The outstanding fact is that twenty-one of the sixty-two cases secured an arrest or apparent arrest. These patients had had an average

PHRENIC NEURECTOMY

period of pre-operative sanatorium care at Loomis of 6.3 months with unsatisfactory progress and persistence of cavity.

The average age of those showing a favorable result was 25.9 years; those over thirty years of age did not do as well. The influence of sex was not marked, and there was no material difference in the response of left- or of right-sided lesions. The degree of elevation of the diaphragm and the amount of vital capacity lost do not appear to be significant factors.

TABLE III

Results in 62 Cases of Phrenicectomy

Combining 24 Pneumothorax Failures and 38 Elective Phrenicectomies

| | Arrests and App. arrests | Quiescent and Improved | Unimproved Given Pneumothorax | Unimproved |
|---|--------------------------------|------------------------------|-------------------------------------|------------|
| Cases | 21 | 30 | 8 | 3 |
| Per Cent | 33.9 | 48.4 | 12.9 | 4.8 |
| Age (Average) | 25.9 | 30.5 | 27.1 | 39.0 |
| Male | 15 | 22 | 3 | 3 |
| Female | 6 | 8 | 5 | 0 |
| Right | 12 | 16 | 3 | 2 |
| Left | 9 | 14 | 5 | 1 |
| Pre-admission months of illness | 21 | 22 | 24.2 | 13.3 |
| Classification on Admission | | | | |
| Minimal | - | - | - | - |
| Moderately Advanced | 10 | 9 | 2 | 0 |
| Far Advanced | 11 | 21 | 6 | 3 |
| Preoperative Sanatorium Months | 6.3 | 6.4 | 6.3 | 5.3 |
| Postoperative Sanatorium Months | 10.5 | 6.9 | 3.9 | 4.4 |
| Elevation of Diaphragm (in cm.) | 3.6 | 3.8 | 3.0 | 2.0 |
| Average percentage loss of Vital Capacity | 9.5 | 10.9 | 11.3 | 7.0 |
| Months to Closure of Cavity | 5.1 | - | - | - |
| Months to Negative Sputum | 5.2 | - | - | - |
| DATA REGARDING CAVITIES | | | | |
| Surrounding Infiltrations: | | | | |
| Light | 7 | 3 | 1 | - |
| Moderate | 13 | 12 | 6 | 2 |
| Heavy | 1 | 15 | 1 | 1 |
| Cavity Wall: | | | | |
| Thin | 13 | 11 | 3 | 1 |
| Moderate | 12 | 18 | 7 | 1 |
| Thick | 1 | 8 | - | 2 |
| Medial | | | | |
| Central | 2 | 1 | 1 | 1 |
| Peripheral | 12 | 9 | 1 | - |
| Mid-Chest | 12 | 27 | 8 | 3 |
| Upper-Chest | 5 | 6 | 4 | - |
| | 21 | 31 | 6 | 4 |

The prognosis was better in the moderately advanced cases. There were, however, eleven arrests or apparent arrests among forty-one far advanced cases, a percentage of 26.8. It is to be noted that those patients who remained under treatment the longest secured the best results. The 5.2 months required for cavity closure after phrenicectomy may be compared with the figure of 5.0 months for cavity closure in successful pneumothorax cases as reported by Herben and Franklin.*

* Positive Pressure Pneumothorax, Its Indications and Results. Address delivered to the Trudeau School of Tuberculosis, Saranac Lake, N. Y., May 26, 1932.

The cavity areas recorded in this table have been roughly computed by multiplying the longest by the shortest diameters of the cavity as measured on an X-ray film taken at a distance of four feet. Obviously this is not entirely accurate, but for purposes of comparing groups of cases the method is useful. The facts set forth in this portion of the table confirm the observations of McMahon and Kerper,* who found that the cavity which is most likely to heal is not over 3 by 3 centimetres has a thin to moderately thick wall, is surrounded by light to moderate infiltration, and is not situated peripherally where a portion of its wall is adherent and immobilized. There is no evidence to indicate that cavities in the upper lobe respond less favorably than those located elsewhere, provided other conditions are comparable.

In a number of patients a discrepancy was noted between the excursion of the diaphragm before operation and its elevation after paralysis, when it was expected that the two would be comparable. In these cases motion of the diaphragm persisted after the operation. This motion did not represent a failure to paralyze the diaphragm, but was passive in nature, due in part to the excursion of the costal margin which caused a flattening of the diaphragm on inspiration, and in part to the abdominal pressure exerted on forced expiration which caused elevation of the diaphragm. This "passive motion of the diaphragm" has not heretofore been mentioned in the literature. Phrenicectomy may not be followed by complete paralysis of the diaphragm since this muscle is innervated also by branches of the lower intercostal nerves (the seventh to the twelfth, according to Spalteholz, the ninth to eleventh according to Cunningham). In one patient, following phrenicectomy, the diaphragm was observed to show a limited downward motion in the absence of marked costal excursion. In this instance the intercostal innervation of the diaphragm was believed responsible for the partial diaphragmatic function which persisted. In eleven instances the average pre-operative excursion of the diaphragm was 5.5 centimetres, the post-operative elevation of the diaphragm measured on inspiration was 3.0 centimetres, and the "passive motion" measured 2.8 centimetres. This point is of practical importance in that the use of an abdominal binder after operation in patients manifesting "passive motion" may serve to increase the elevation of the diaphragm and thus augment relaxation of lung. It is also evident that X-ray observation of the effect of phrenicectomy requires films taken on deep inspiration and after normal—not forced—expiration.

In this series there were no serious operative accidents and no deaths. There were two superficial wound infections; in one case trauma to the sympathetic nerve resulted in a Horner's syndrome which disappeared in two months; in one case the external jugular vein was cut and ligated, and the thrombus which appeared was promptly absorbed. Brief post-operative elevation of temperature occurred once. The symptoms of brachial neuritis of traumatic origin occurred in two cases with recovery within two weeks. In

* The Healing of Tuberculous Cavities: A Clinical Study. Address delivered to the Eastern Section of the American Sanatorium Association, Waltham, Mass., October 14, 1932. (To be published in the American Journal of Medical Sciences.)

two patients with marked elevation of the diaphragm pulmonary atelectasis occurred; in one the entire left lung was involved, in the other the right lower lobe. Both received pneumothorax. The possibility of this complication must be borne in mind as it materially alters the problem of treatment. While many patients noticed slight dyspnoea in the early post-operative period, a quick readjustment was usually made and this was not a troublesome symptom in any case. Complaints of abdominal gas were varied, and apparently were somewhat more frequent in the patients with left-sided diaphragmatic elevation and subsequent increase in the "stomach bubble."

SUMMARY

Phrenicectomy is indicated and is a valuable independent collapse procedure when operative intervention is required in the treatment of a limited group of patients with pulmonary tuberculosis who have not responded to routine sanatorium care. The clinician's aid is important in selecting the cases suitable for operation. This collapse procedure is regarded as successful only when it is followed by closure of cavity as shown by X-ray and by consistently negative sputum. The best post-operative results are found in cases with a thin-walled cavity not over 3 by 3 centimetres in diameter with little surrounding infiltration and located centrally in the lung parenchyma. On the other hand, phrenicectomy promises little and should not be used in those cases with dense infiltration, thick-walled cavities, or large cavities.

Sixty-two cases in which phrenicectomy was the only operative procedure affecting the course of pulmonary tuberculosis are analyzed in detail, showing 14.5 per cent. discharged arrested, with sputum negative on concentration for six months or more; 19.4 per cent. apparently arrested, with sputum negative on concentration for at least three months; 29.0 per cent. quiescent, with constitutional symptoms absent for at least two months, but without consistently negative sputum; 19.4 per cent. improved, with constitutional symptoms lessened; 4.8 per cent. unimproved, with essential symptoms unabated; and 12.9 per cent. in which it was necessary to give pneumothorax.

An original observation is recorded describing "passive motion of the diaphragm" following phrenicectomy; the motion is due to a combination of marked costal excursion, which will flatten the diaphragm on inspiration, and to a rise of the diaphragm caused by forced expiration.

BIBLIOGRAPHY

- ¹ Matson, Ray W.: Exairexis of the Phrenic Nerve in the Treatment of Pulmonary Tuberculosis. *Am. Rev. Tuberc.*, vol. xxii, p. 1, July, 1930.
- ² Alexander, John: Operative Technic of Phrenic Nerve Interruption. *Surg., Gynec., and Obst.*, vol. xlix, p. 372, September, 1929.

BRONCHOSCOPICAL OBSERVATIONS ON POST-OPERATIVE PULMONARY COMPLICATIONS*

BY CHEVALIER JACKSON, M.D.

AND

CHEVALIER LAWRENCE JACKSON, M.D.

OF PHILADELPHIA, PA.

FROM THE BRONCHOSCOPIC CLINIC OF TEMPLE UNIVERSITY

FIVE distinct types of post-operative pulmonary complications have been observed in our experience:

- (1) *Post-operative atelectasis*; chiefly following abdominal operations; not primarily suppurative.
- (2) *Post-tonsillectomic suppuration*; chiefly following tonsillectomy and other operations about the upper air passages; suppurative from the onset.
- (3) *Foreign bodies inspired* during operations about the upper air passages; not primarily suppurative.
- (4) *Infarct* that may follow operation upon any region.
- (5) *Pneumonitis*, usually called post-operative pneumonia.

This loose grouping of cases is for the purpose of study of certain contrasts; it is not claimed that every case of post-operative suppuration can necessarily be placed in one or other of the groups; additional groups could be cited.

In order to present certain contrasts, groups 4 and 5 will be omitted. This omission is necessary for other reasons, chief of which are that in the clinical work on which this paper is based it was impossible to determine that any case was due to infarct; and the term pneumonia is so loosely applied that the term "post-operative pneumonia" in the history means nothing definite.⁸ It might have been an infarct but probably in most cases it was some form of bronchial obstruction with or without atelectasis, with or without drowned lung. A new era is dawning now that Röntgen-ray examination at the bedside and early objective examination with the bronchoscope are being used to assist in diagnosis.^{2, 8}

In the following tabulation there are certain contrasts that we believe have an important bearing on the etiology, diagnosis, prophylaxis and treatment of post-operative pulmonary complications.

Post-operative Atelectasis.—In these cases, formerly mistaken for post-operative pneumonia, there is at the onset a thick, tenacious, obstructive secretion that at first contains grossly no pus and on microscopical examination only a few pus-cells and few if any pyogenic bacteria.² If not quickly terminated by restoration of ventilation and drainage with consequent re-establishment of the defensive powers of the lung the atelectasis is slowly succeeded

* Presented at the Fourth Congress of the Pan-American Medical Association, Dallas, Texas, March 21, 1933.

BRONCHOSCOPICAL OBSERVATIONS

POST-OPERATIVE PULMONARY COMPLICATIONS

| Post-Tonsillectomic Suppuration | Post-Operative Atelectasis | Post-Operative Foreign Body |
|--|---|---|
| (1) Follows operations about the upper air passages, most often tonsillectomy. | (1) Follows abdominal operations. | (1) Follows inspiration of foreign body during operation. |
| (2) Onset sudden. | (2) Onset sudden. | (2) Onset gradual, even if obstructive atelectasis is produced by the foreign body. |
| (3) Primarily suppurative. | (3) Not primarily suppurative. | (3) Not primarily suppurative. |
| (4) Abscess forms early, namely, within a few days, and very rapidly. | (4) Abscess late, if at all. | (4) Abscess late, if at all; a year or more in cases of steel foreign body; three months or more in cases of tooth, and it was not in any case a cavity associated with fluid level but rather a condition of drowned lung. |
| (5) Abscess shows cavity and fluid level early. | (5) Drowned lung first suppurative feature, if any. | (5) Local suppurative bronchitis. If complete obstruction drowned lung may follow atelectasis. |
| (6) Expectoration of pus and blood at onset very foul, gangrenous. | (6) Expectoration at onset absent or scanty, rarely, if ever, purulent or bloody, or odorous. | (6) Expectoration at onset absent or scanty; if a tooth, mucopurulent in a few cases; if non-obstructive steel instrument, may be months or years. |
| (7) Breath very foul at onset. | (7) Foul breath not a feature. | (7) Foul breath not an early feature. |

by suppuration first in the form of drowned lung, purulent bronchitis, later abscess, possibly bronchiectasis. If, on the other hand, early bronchoscopical drainage promptly restores ventilation and drainage, as it usually does (Figs. 1 and 2), there is no tendency to the formation of a localized purulent collection. We rarely, in these cases, see anything remotely resembling an abscess cavity with fluid level such as is regularly seen in suppurative complications following tonsillectomy and operations on the upper air passages. The pathological products in atelectasis are largely if not altogether endobronchial.

These clinical facts, now well established by bronchoscopical observations, clearly prove that post-operative atelectasis is not suppurative at the onset. Moreover, these observations indicate that primarily it is not even an infective process.

Pulmonary Suppuration Following Operations on the Upper Air Passages.—Typical examples of this complication are most frequently seen after



FIG. 1.

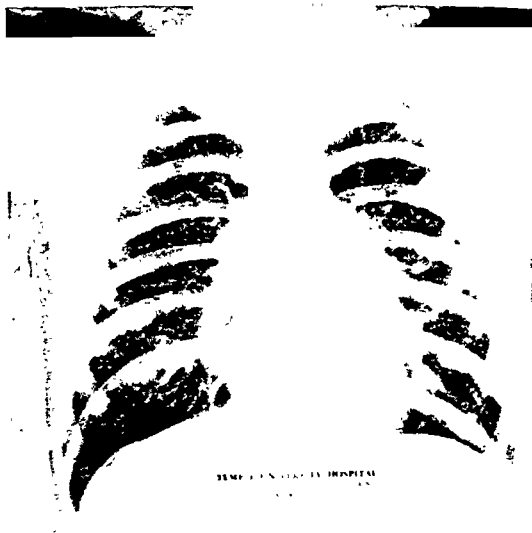


FIG. 2.

FIG. 1.—Röntgenogram of a man aged twenty-one years, showing atelectasis of the left lung that followed three days after appendectomy under spinal procaine anæsthesia. This type of post-operative complication follows abdominal operations, rarely, if ever, tonsillectomy or other operations on the upper air passages. The use of spinal anæsthesia eliminates inhaled ether as an etiological factor in this case. The air in the abdominal cavity (B) suggests the possibility that the abolition of the abdominal relations with the mechanism of respiration that normally exist so long as the abdomen is closed has a bearing on the etiology of post-operative atelectasis. This refers especially to conditions during the time the abdomen is open.

FIG. 2.—Here is seen the effect of promptly done bronchoscopic aspiration (C. L. J.).

tonsillectomy, but the same clinical features characterize the disease when it follows other operations about the upper air passages.^{1, 2, 5} These clinical features are essentially different from those of pulmonary complications, especially atelectasis, following abdominal operations and totally different from

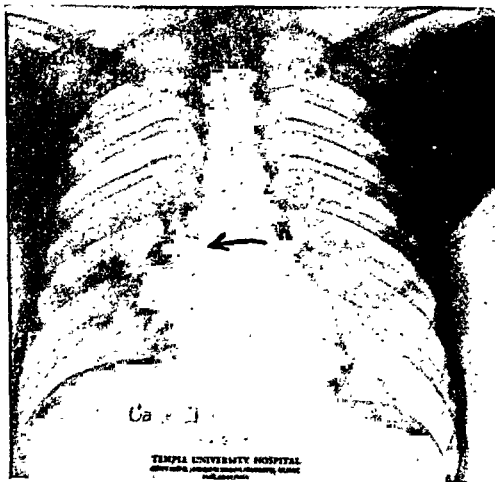


FIG. 3.

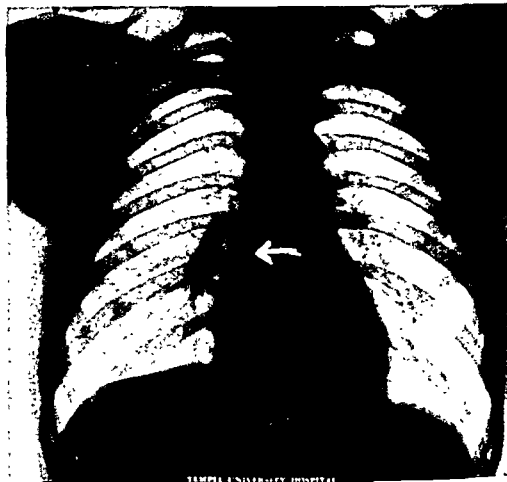


FIG. 4.

FIG. 3.—Röntgenogram of a man aged twenty-two years, showing shadows of a pulmonary abscess that followed six days after operation under ether, on the external nose for traumatic deformity. The pulmonary condition, sudden cavitation, as well as in its fulminating onset and other clinical features, was identical with what follows tonsillectomy. In this case the tonsils were extensively diseased but were not touched at operation. This and similar cases suggest that the question of the cause and route of infection in post-tonsillectomic pulmonary suppuration are closely linked with the larger question of descending upper respiratory infections independent of operation on the tonsil itself, or, indeed, of any operation.

FIG. 4.—After bronchoscopic aspiration (C. L. J.) the abscess was healed completely as shown here.

BRONCHOSCOPICAL OBSERVATIONS

TEMPLE UNIVERSITY HOSPITAL
PHILADELPHIA, PA.
GRAPHIC CHART

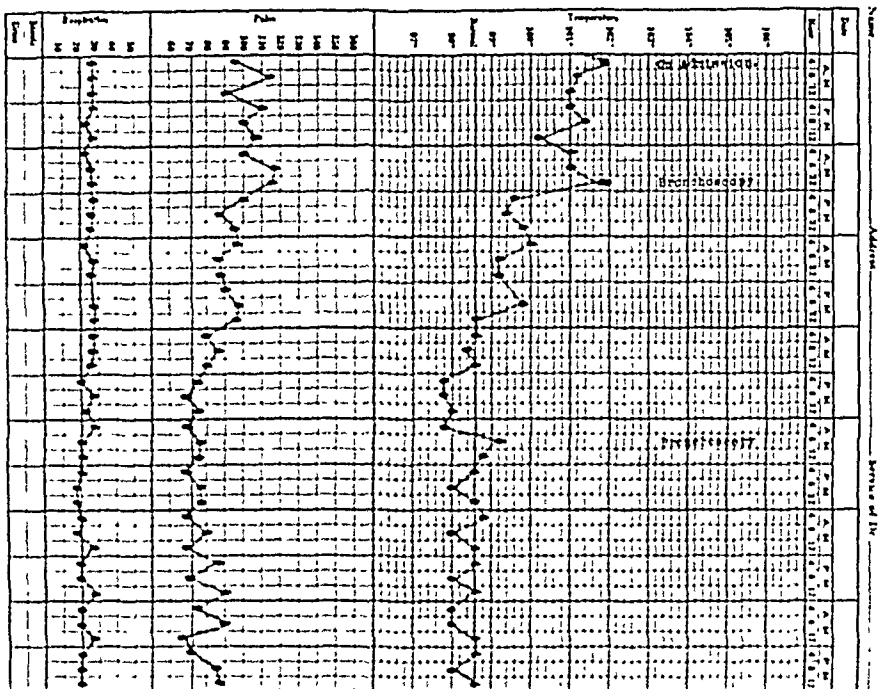


CHART 1.

TEMPLE UNIVERSITY HOSPITAL
PHILADELPHIA, PA.
GRAPHIC CHART

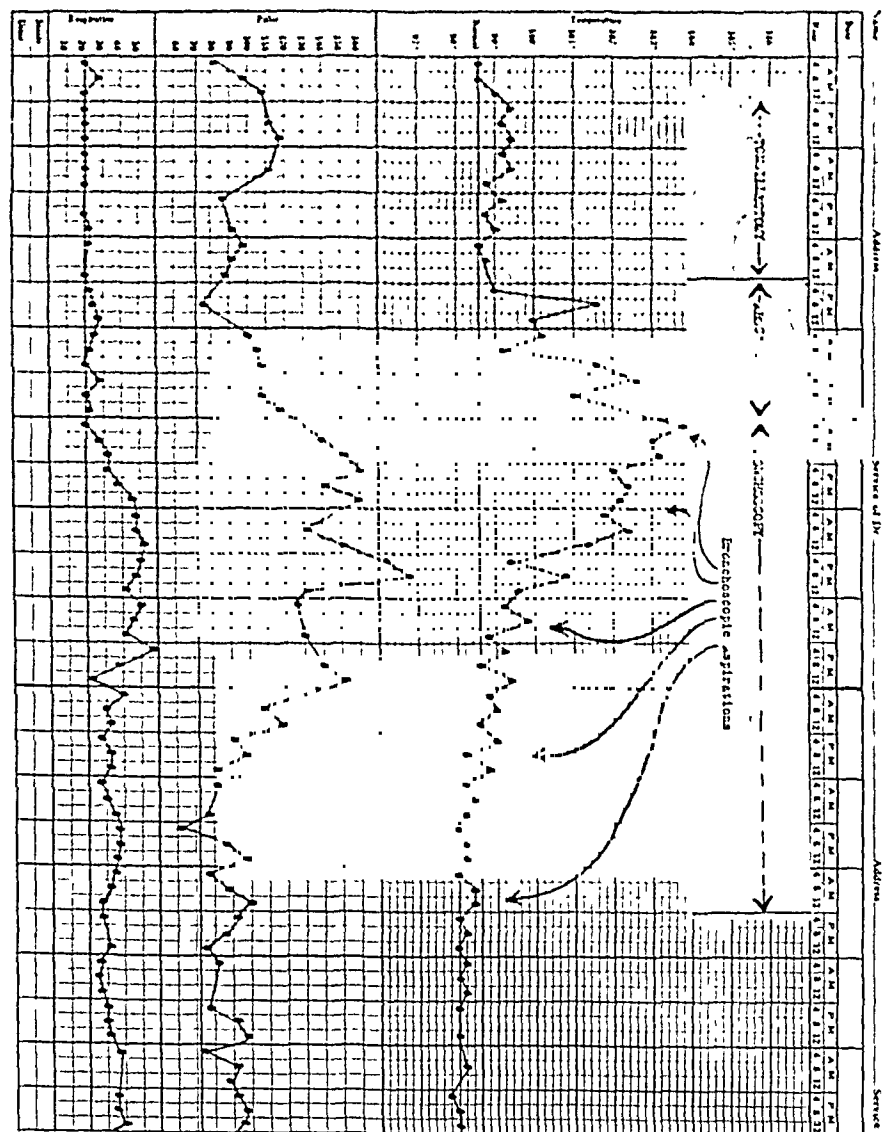


CHART 2.

those following the inspiration of foreign bodies at operation on the upper air passages.

In a typical case of pulmonary complication following tonsillectomy or other operation about the upper air passages, the patient is taken suddenly ill with prostration, high fever, chilliness within a week or ten days after operation. (Chart 2.) Among the initial symptoms there is expectoration of a rather large quantity of foul, usually bloody pus, the patient's breath is fetid and a röntgenogram at this stage always shows a localized inflammatory area and usually a cavity with fluid level. If such a level is not at once apparent it soon becomes recognizable; if bronchoscopical aspiration be done the cavity is seen to be evacuated and a fluid level is seen later as it refills. (Figs. 3, 4, 5, 6, 7 and 8.)



FIG. 5.



FIG. 6.

FIG. 5.—Röntgenogram of a man aged thirty-six years, showing a post-tonsillectomic abscess of the left upper lobe cured after eight bronchoscopical aspirations. (Aucoin.)

FIG. 6.—Röntgenogram after treatment. This is one of twenty-seven cases showing that the upper lobes can be efficiently drained by bronchoscopy when done without anæsthesia. The aspirating tube goes around the corner into the ascending upper lobe branches, but the most important factor is the "tussive squeeze" that forces the pus from the periphery toward the stem bronchi.

Pulmonary Complications Following Inspiration of Foreign Body at Operation.—It is not intended here to refer to the more than 1,500 cases of inspired foreign body in the records of the clinic.^{1, 6, 7, 9} In those cases the foreign body went through the mouth and necessarily carried infection. That the infection was not in any case followed by abscess such as we see after tonsillectomy is significant; but in most of those cases there were not the conditions that are present at a tonsillectomy, bleeding, inspiration of blood, anæsthesia, abolition of reflexes, especially the cough reflex, that might favor abscess formation. We wish to refer only to a class of case in which a foreign body was inspired during tonsillectomy or other operation in the upper air passages, presumably accompanied by all the just mentioned conditions. A rather large number of the latter class of case have come to the

BRONCHOSCOPICAL OBSERVATIONS

Bronchoscopic Clinic and from them some very interesting and important data have been accumulated.^{1, 4, 7} The clinical features are quite different from the post-operative atelectasis following abdominal operations on the one hand and the sudden abscess formation with shock, high fever, prostration and profound sepsis, following tonsillectomy and nasal operations, on the other.

In a typical case of foreign body inspired at operation the patient gives no sign of ill-health for a number of weeks or sometimes months afterward, depending on the character of the foreign body and especially the degree of obstruction its shape may enable it to produce. A non-obstructive piece of steel instrument may cause no symptoms for many months.⁷ A tooth or piece of human bone¹ on the other hand usually causes a slight cough within a few days; within a few weeks there may be slight expectoration; in a few



FIG. 7.



FIG. 8.

FIG. 7.—Röntgenogram of a boy aged thirteen years, showing a post-tonsillectomic abscess in the upper lobe near the root of the left lung. Because of the parahilar location the surgeon deemed thoracotomy contra-indicated and referred the patient to the bronchoscopical department.

FIG. 8.—This röntgenogram, taken after four bronchoscopical aspirations (C. L. J.), shows disappearance of the pathological shadows. The patient was and has since remained symptom-free. This is another one of the twenty-seven cases of upper lobe abscess demonstrating the high degree of efficiency of bronchoscopical aspiration of the upper lobe, when done without anæsthesia so as to obtain the aid of the tussive squeeze.

months some foul pus and a slightly fetid breath.¹⁰ At this secondary stage the Röntgen-ray examination shows no cavity with fluid level.¹⁰ Granulations and a localized suppurative bronchitis are found at bronchoscopy but this entirely disappears in a few weeks after bronchoscopical removal of the foreign body.^{7, 10} If the foreign body be not removed until after many months in obstructive cases there may be a localized purulent collection but no abscess cavity with fluid level. Considering the fact that a carious tooth probably carries with it as great a variety of infective agents as are contained in the tonsil or the nasal cavities this endobronchial limitation of the suppurative process is in very striking contrast to the sudden parenchymal abscess formation seen in post-tonsillectomic cases unassociated with foreign body.¹

These observations are based not upon a case or two but upon a relatively large series (47 cases) including teeth dislodged during exodontia³ and ton-

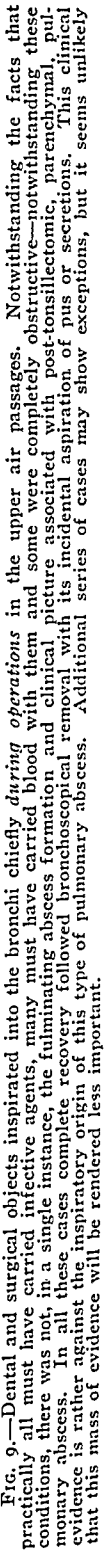


FIG. 9.—Dental and surgical objects inspired into the bronchi chiefly *during operations* in the upper air passages. Notwithstanding the facts that practically all must have carried infective agents, many must have carried blood with them and some were completely obstructive—notwithstanding the conditions, there was not, in a single instance, the fulminating abscess formation and clinical picture associated with post-tonsillectomy, paracroupal, pulmonary abscesses. In all these cases complete recovery followed bronchoscopic removal with its incidental aspiration of pus or secretions. This clinical evidence is rather against the inspiratory origin of this type of pulmonary abscess. Additional series of cases may show exceptions, but it seems unlikely that this mass of evidence will be rendered less important.

sillectomy sponges from the tonsillar fossa,¹ nasal rasps,² dental and tonsil instruments,¹ portions of turbinate and alveolar bones,¹ blood clots, *etc.*^{8, 9} (Fig. 9). These cases have been reported in the articles to which references are appended. There is one recent case, however, that presents so many remarkable and important features apropos of the present subject that it is here given.

CASE I. (Fbdy. 2795.) *Portion of tonsil removed bronchoscopically from the left lower-lobe bronchus after seven months' sojourn in a girl aged seven years.* For three months after tonsillectomy there were no symptoms. Then slight cough, dry at first, appeared and gradually became somewhat productive. Occasional slight elevation of

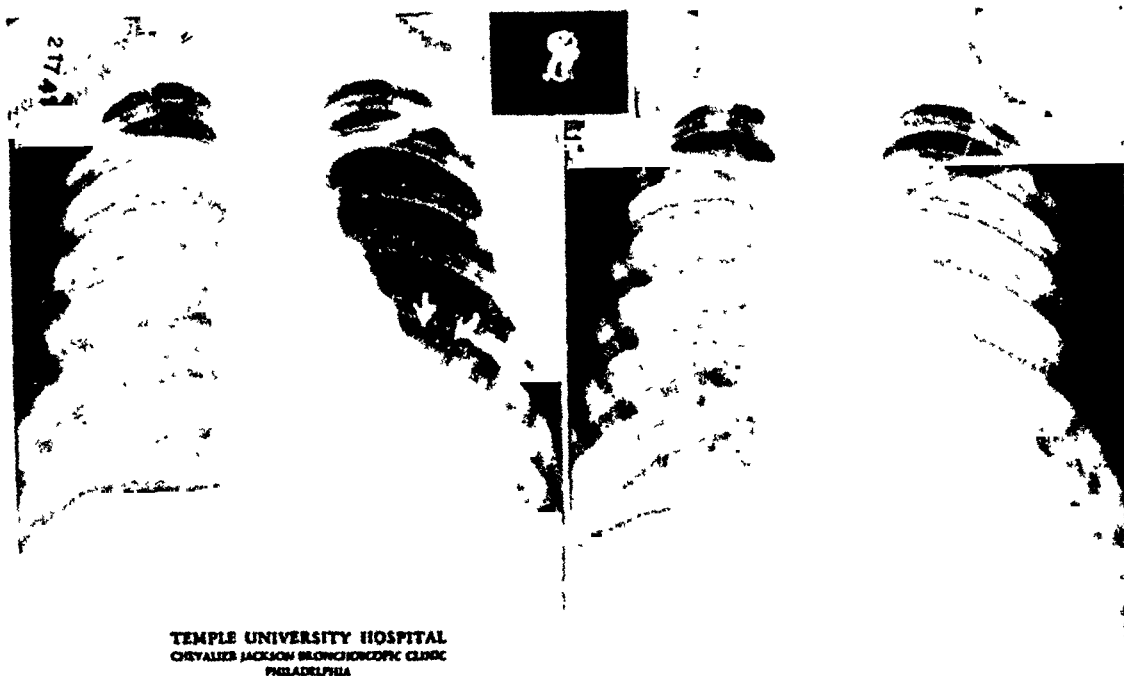


FIG. 10.

FIG. 11.

FIG. 10.—Röntgenogram showing a slight shadow of atelectasis and drowned lung due to the seven months' sojourn of a tonsil in the left bronchus. Notwithstanding the probable presence of blood clots, the prolonged obstruction of a bronchus by the tightly fitting plug of tonsillar tissue filled with septic material no ill-health sufficient to keep the child out of school resulted, and not one of the clinical features of post-tonsillectomic pulmonary abscess were present. The symptomless interval of two months, the mildness of the symptoms when they did develop and the prompt recovery after bronchoscopical removal were all features commonly seen in non-septic, bronchially lodged foreign bodies. They are in marked contrast to the fulminating onset of post-tonsillectomic pulmonary abscess (Chart 2), and they point to the previously noted¹⁰ great defensive power of the lung against invasion by way of the bronchial mucosa.

FIG. 11.—Röntgenogram of the same patient as in Fig. 10, showing the complete disappearance of the pathological shadow in three weeks after bronchoscopical removal of the tonsil that had been in the lung for seven months. The inset is from a photograph of the tonsil reduced in the same proportion as the röntgenogram.

temperature was noted during the sixth and seventh month after tonsillectomy. The father who is a physician had a Röntgen-ray examination made; it revealed atelectasis of the left lower lobe. He then brought the child to the Bronchoscopic Clinic of Temple University Hospital seven months after tonsillectomy. On admission the child had a moderate and slightly productive cough, temperature, 99.4°. She did not seem ill, and certainly was not toxic. Röntgen-ray and physical examinations indicated atelectasis or drowned lung, or both, in the left lower lobe. (Figs. 10 and 11.)

Bronchoscopy without anæsthesia, general or local, revealed a small amount of pus in the trachea. This was found to come from the left bronchus. After aspirating this, a whitish nodular obstruction was found occluding the left lower-lobe stem below the orifice of the left upper lobe bronchus. This was removed with side-bent forceps, liberat-

ing a small amount of pus which was aspirated. A slightly unpleasant odor was noted but it was not foul. Upon examination of the nodular soft foreign body it was found to be tissue grossly resembling the amputated portion of a tonsil; it was not putrid. Microscopical examination by Dr. Frank R. Konselmann, pathologist of Temple University Hospital, showed the specimen to be made up of tissue infiltrated with lymphocytes. The stroma was well preserved but the lymphoid structure was largely replaced by chronic inflammatory tissue. Progress after removal was uneventful. At the end of two months, cough, expectoration and all other symptoms had ceased without treatment other than an outdoor régime. A röntgenogram showed complete disappearance of all pathological shadows. (Fig. 11.)

Comment.—It seems remarkable that so septic a thing as a mass of tonsillar tissue should remain in a bronchus for seven months without being destroyed, without becoming putrid and without producing a violent suppurative reaction with abscess formation in the invaded lung. Every clinical feature of the case resembled the usual slowly developing pathology of foreign body in the bronchus and was in marked contrast to the sudden abscess formation and fulminating onset of post-tonsillectomic abscess unassociated with foreign body. All of the etiological factors deemed essential for the production of abscess were present, bronchial obstruction, blood-clots, prolonged contact of a relatively large quantity of septic material held in the tonsil itself. It seems reasonable to suppose that if a minute piece of that tonsil had been introduced into a tonsillar vein pulmonary abscess from septic infarct would have resulted, because the infection would have thus been introduced behind the epithelial barrier of the bronchial mucosa.

Inspiration of Blood at Operation.—Undoubtedly, blood is inspired at nearly every tonsillectomy. The anterior and downward displacement of the tongue with the tongue depressor necessary to expose the tonsil to view creates a funnel the bottom of which is the always open larynx; but what seems of even greater importance is the fact that so long as the tongue is held down the patient cannot readily swallow, because the first swallowing movement normally is the rising of the tongue to the roof of the mouth. Some blood is swallowed in the intervals between depressions of the tongue and afterward; but during the depressions what is not aspirated by the surgeon is inspired into the tracheobronchial tree by the patient. The mechanism involved is easily demonstrated; if a person not anæsthetized attempts to swallow water while the tongue is instrumentally depressed he cannot swallow and he will usually choke and strangle from the entrance of fluid into the larynx. Though blood is inspired into the tracheobronchial tree at almost every tonsil operation under general anæsthesia it does not necessarily follow that post-tonsillectomic abscess is necessarily due to the inspiration of blood and infective materials. The relative rarity of abscess is rather against this as the route; and anyway demonstrates, again,¹⁰ the marvelous defensive power of the lung against infective invasion by way of the bronchial mucosa.

The Bronchiectatic Septic Tank.—Bronchiectasis is, in some cases, a tertiary sequel of operation. Developing slowly after a post-operative atelectasis or suppurative pulmonary condition, and being practically always

associated with a focal infection in the sinuses or lymphoid tissue, it is always a question whether or not bronchiectasis would have developed anyway; it is clear that there must be other etiological factors. Chief of these is the bronchiectatic septic tank. By this is meant nature's way of getting rid of thick viscid secretions by first thinning them by putrefactive processes.¹¹ The products and by-products of these changes though rendered easy of expulsion are intensely irritating to the bronchial walls and constitute one of the factors in the changes in those walls as well as in the perpetuation of the disease. The existence of the bronchiectatic septic tank has been demonstrated by bronchoscopical studies and these studies have demonstrated that it can be eliminated by bronchoscopical aspiration done before the thickened secretions undergo putrefaction.¹¹

Sedatives.—The tendency to regard cough as like pain, a thing to be suppressed with sedatives, is an error; it is a natural defensive reflex, the watchdog of the lungs, not only guarding against invasion but, aided by the hecic blast and the tussive squeeze, repelling intruders that have gained access. The suggestion that the cough reflex should be abolished because it helps to scatter infection ignores the fact that it is unthinkable and impossible to abolish it forever; sooner or later the patient must cough, if he survives the operation, and when he does whatever scattering may be done by cough will then be done after long sojourn. It would seem more logical to depend upon uninterrupted cough to get rid of the scattered as well as the unscattered material promptly, just as the florist by many compressions empties the sprinkling bulb, sucking in air between compressions. Atropine lowers tussive efficiency by increasing viscosity. Its use before, during or after operations is illogical and unnecessary.

CONCLUSIONS

(1) Observations on cases referred to the Bronchoscopic Clinic for diagnosis and treatment of post-operative pulmonary complications show certain contrasts that would seem to have an important bearing on the etiology, diagnosis, prophylaxis and treatment of this class of pulmonary diseases.

(2) Post-operative atelectasis in almost all of our cases had followed abdominal operations; it is a condition not primarily suppurative; when suppuration follows later it is endobronchial and may eventually end in drowned lung if unrelieved. The obstructive bronchial secretions causing the atelectasis contain an excess of fibrin, but few pus cells, grossly no pus and few, if any, pyogenic bacteria.

(3) Post-operative foreign body such as a tooth, a human bone, a nasal, dental or tonsillar instrument or a portion of tonsil does not primarily produce a purulent lesion. The onset of suppuration is gradual, often requiring months, and the pus-formation is strictly endobronchial. This is remarkable and important when one considers the resultant obstruction as well as the blood and infective material that all such foreign bodies must carry with them into the bronchi.

(4) Pulmonary complications following operations on the tonsils and upper air passages are suppurative from the onset; the start is sudden, often fulminating; the suppuration is usually a parenchymal abscess emptying into a bronchus. This is in strong contrast to the non-suppurative onset in cases of post-operative atelectasis on the one hand and of post-operative foreign body on the other.²

(5) The logical conclusion from these contrasts is that post-tonsillectomic abscess is not usually an inspiratory infection but an infective embolic process. However, it would not be wise to say that inspiratory infective processes could not in any case produce such an abscess.

(6) Bronchoscopy is strongly indicated at the earliest possible moment in all varieties of post-operative pulmonary complications. To say that bronchoscopical aspiration is not needed in any case on the basis of recoveries without it is equivalent to saying transfusion is not necessary because of recoveries in cases where it was indicated but not given. The improved condition of the patient after bronchoscopical aspiration, for post-operative atelectasis is just as striking as that in a patient after a much-needed transfusion of blood.

(7) In post-tonsillectomic abscess the cilia are overwhelmed by the dumping into the bronchi of a large quantity of thick pus from a parenchymal abscess. Bronchoscopical aspiration takes the load off the cilia and restores the defensive powers of the lung by reestablishing ventilation and drainage.

(8) Bronchoscopical aspiration is supplemented by the "tussive squeeze." That is, the compression of the lung during cough squeezes the pus out of the parenchyma and smallest bronchi to within the reach of the aspirating tube. It is not necessary that the tube be always inserted into the abscess cavity or out to the periphery of the upper lobe. The tussive squeeze empties the upper lobe into the main bronchus.¹¹

(9) The prophylaxis of atelectasis consists in (a) avoidance of sedatives, such as morphine and codein, that lessen the tussive squeeze and bechic blast, and of drugs such as atropine, that increase viscosity of secretions; (b) avoidance of operations during or shortly after influenza and other acute respiratory infections; (c) examination of the nasal sinuses and larynx before every operation; (d) Röntgen-ray examination of the chest before every major operation. This would also eliminate post-operative blame for pre-operative pathology.

(10) It is a fallacy to arrest the cough reflex during operations in an effort to prevent scattering of infective or obstructive materials. The patient must cough sooner or later and will then have an accumulation to scatter. Scattering of infective materials by cough is of no consequence if the cough reflex is free to work unhampered by sedatives.

(11) Once suppuration is established the prophylaxis of bronchiectasis depends largely upon elimination of the bronchiectatic septic tank by aspirating the thick, viscid pus without allowing it to wait for putrefactive processes to thin it in order to facilitate its tussive expulsion.¹¹

(12) The instrumental depression of the tongue at tonsillectomy prevents swallowing and creates a funnel leading to the always open larynx. The result is that blood and infective materials are inspired into the tracheo-bronchial tree at practically every tonsil operation; if this is the route followed by the infection causing post-operative pulmonary abscess the rarity of such a sequel is evidence of a most marvelous defensive power of the lung against infective invasion by way of the bronchial mucosa.

(13) Bearing on the question as to which of the various routes is traversed by the infective agent in the pathogenesis of post-tonsillectomic abscess, (a) air passages, (b) blood-vessels, (c) lymph channels, (d) air passages plus bronchial lymph channels, (e) lymph vessels plus peritonsillar veins, our observations indicate that whereas the treatment is clearly indicated the etiology, pathogenesis and prophylaxis of the post-operative pulmonary suppuration are intimately involved with the as yet unsettled larger question of descending upper respiratory infections in patients not operated upon.

BIBLIOGRAPHY

- ¹ Jackson, Chevalier Lawrence: Bones as Overlooked Foreign Bodies in the Lung. *Arch. of Otolaryngol.* vol. xii, pp. 499-507, October, 1930.
- ² Jackson, Chevalier, and Jackson, Chevalier Lawrence: *Bronchoscopy for Pulmonary Disease; Nose, Throat and Ear and Their Diseases.* Text-book, Jackson-Coates, W. B. Saunders Co., 1929.
- ³ Jackson, Chevalier: Bronchoscopic Cases of Dental Interest; Dental Foreign Bodies in the Air and Food Passages. *Jour. Am. Dental Assn.*, August, 1927.
- ⁴ Jackson, Chevalier: Chronic Non-specific Infections of the Lungs. *Jour. Am. Assn.*, vol. lxxxvii, No. 10, p. 729, September 4, 1926.
- ⁵ Jackson, Chevalier: Post-Tonsillectomic Pulmonary Abscess. *Atlantic Med. Jour.*, February, 1926.
- ⁶ Jackson, Chevalier: Overlooked Cases of Foreign Body in the Air and Food Passages. *British Med. Jour.*, p. 686, October 17, 1925. Discussion by Thomas McCrae and Others.
- ⁷ Jackson, Chevalier: Observation on the Pathology of Foreign Bodies in the Air and Food Passages Based on the Analysis of 628 Cases. *Mutter Lecture, 1917. Surg., Gynec., and Obst.*, pp. 201-261, March, 1919.
- ⁸ Jackson, Chevalier Lawrence: *Bronchoscopy in the Treatment of Pulmonary Disease.* International Clinics, vol. ii, Series 41. J. B. Lippincott Company, 1931.
- ⁹ Jackson, Chevalier, and Jackson, Chevalier Lawrence: *Foreign Bodies in the Air and Food Passages.* W. B. Saunders Co. (In preparation.)
- ¹⁰ Suppurative Diseases of the Lung Due to Inspired Foreign Body Contrasted with Those of Other Etiology. *Surg., Gynec., and Obst.*, vol. xlii, p. 305, March, 1926.
- ¹¹ Jackson, Chevalier: Rapport sur le traitement endoscopique des suppurations tracheo-bronchiales. *Comptes rendus Congres International d'Oto-Rhino-Laryngologie*, Madrid, le 27 Septembre, 1932; also published in *Revista Espanola y Americana de Laryngologia, Otologia y Rinologia*, Madrid, 1933.

PENETRATING STAB WOUNDS AND BULLET WOUNDS OF THE CHEST

A STUDY OF SIXTY-EIGHT CASES OPERATED UPON BETWEEN JUNE 1, 1931,
AND APRIL 30, 1932, WITH A DESCRIPTION OF A NEW OPERATIVE
PROCEDURE OF EXTRAPLEURALIZATION AND EXTERIORIZATION
OF THE PULMONARY LACERATION*

BY JOHN F. CONNORS, M.D. AND JOSEPH B. STENBUCK, M.D.
OF NEW YORK, N. Y.

FROM THE SURGICAL SERVICE OF THE HARLEM HOSPITAL

UNTIL June, 1931, the treatment at the Harlem Hospital of penetrating wounds of the chest was not different from that in most other hospitals. That is to say, the superficial wound was either closed by suture or packed with gauze. The patient was observed for complications which might require further treatment. It is true that a great many patients were cured without further intervention other than simple closure, but not infrequently it was found that patients who did well at first soon succumbed to hæmorrhage or infection, in spite of frantic efforts to remedy the damage. Indeed, we were so much impressed by the deaths of three patients from seemingly preventable causes within a period of two weeks in May, 1931, that the senior author decided that all cases should be operated upon on admission to the hospital to arrest hæmorrhage from the internal mammary and the intercostal arteries, if severed.

CASE I.—One of the three deaths was in the case of a patient admitted with a stab wound in the right second intercostal space close to the sternal border. He showed signs of marked hæmorrhage but his pulse became normal and his condition improved after an injection of physiological saline solution and the administration of morphine. He was placed in the Trendelenburg position and wrapped with warm blankets. For a few hours he seemed to be improving. This improvement, however, gave us a false sense of security, because after four or five hours he was dead from a tremendous intrapleural hæmorrhage demonstrated at post-mortem examination.

Apparently bleeding had stopped temporarily in this case because the initial hæmorrhage had lowered arterial pressure sufficiently to prevent much flow from the severed internal mammary artery. The supportive treatment instituted produced an increase in arterial pressure sufficient to start bleeding again. With the second hæmorrhage, in a patient already almost exsanguinated, death followed soon. Our subsequent experiences led us to believe that if the severed internal mammary artery had been controlled by ligature before the second hæmorrhage occurred the patient's chances would have been greatly enhanced. The sequence, (1) *hæmorrhage and collapse* followed by (2) *improvement in the condition* of the patient by rest and supportive treatment, and (3) *a second hæmorrhage and collapse* due to improved arterial force, followed by (4) *death*, is not uncommon.

CASE II.—This patient received a stab wound in the left third intercostal space about one inch from the left sternal border. He progressed comparatively well for a period of

* Read before the Section of Surgery, Academy of Medicine, New York, May, 1932.

PENETRATING STAB WOUNDS AND BULLET WOUNDS OF THE CHEST

eight days when a hemothorax which he had originally developed became infected. The wound had been treated with simple suture and the patient bore the infected hemothorax well as long as the wound remained closed. However, when the wound broke down, pus poured forth, and a sucking wound developed with marked cardiac and pulmonary embarrassment. Many devices were tried in an attempt to make air-tight drainage through this infected orifice but without success.

Several factors entered in the death of this patient, the most important of which was a sucking wound permitting displacement of the mediastinum, collapse of the left lung and partial collapse of the right lung, which produced a decrease in pulmonary ventilation. The abnormal position of, and pressure upon, the heart and great vessels increased the embarrassment of circulation.

CASE III.—A young woman was stabbed in the third left intercostal space close to the border of the sternum. The wound was closed by suture. She developed a large hemothorax which became infected. On the fifth day it was drained with a tube through a counter incision at a dependent portion of the pleural cavity and the tube was placed under water. Air-tight drainage was difficult to maintain. The patient became rapidly worse, showing signs of marked collapse and toxæmia leading to death. The problem here was similar to that of Case II. In all these cases, last-minute heroic measures to save the patient were quite useless.

With these cases in mind we abandoned the *laissez faire* method of treatment (which characterizes the first period in mode of treatment) and entered upon the second period, in which we operated by various methods upon thirty-two patients. In this group, many data were accumulated and two entirely new operative procedures were developed by the junior author. After the operation of exteriorization of the lung was developed it was employed routinely (third period) and when thirty-two patients had been operated upon the results of the three periods were compared.

In the *first period*, June 1, 1930, to May 31, 1931, there were forty-five cases of penetrating wounds of the chest with eleven deaths, mortality 24.4 per cent.

In the *second period*, June 1, 1931, to November 10, 1931, there were thirty-two cases with seven deaths, mortality 21.8 per cent.

In the *third period*, November 11, 1931, to April 21, 1932, there were thirty-two cases with four deaths, mortality 12.5 per cent.

In the entire period there were five wounds of the heart. In each instance the patient died.

The Examination of Patients upon Admission.—The patient usually presents a single wound. Frequently it is impossible to determine whether the thorax was penetrated. Some of the so-called cardinal signs of penetration have been found in non-penetrating wounds, while frequently, in the early hours, penetrating wounds showed no signs of penetration. In three cases we saw patients on admission present signs of marked collapse, a picture which we learned to associate in these cases with severe bleeding and with large hemothorax; nevertheless, operation revealed no penetration through the chest-wall.

Additional misleading phenomena are the following; a sucking wound may occur without penetration when forced respirations cause air, beneath

the large muscles of the chest-wall to pass back and forth through a superficial wound. Subcutaneous crepitation has been misleading when it was due to air sucked into the wound and then forced under the skin. Sometimes a blood clot gives crepitus. Even pneumothorax demonstrated in röntgenograms measured with a pneumothorax apparatus was found in a case in which the wound did not penetrate beyond the intercostal muscles. In one case the X-ray film showed a shadow which usually is interpreted as fluid but operation proved that it was due to old fibrous adhesions between visceral and parietal pleuras.

We do not desire to give the impression that these exceptions to the cardinal signs are common, but merely wish to call attention to the fact that they may occur.

The clinical picture on admission frequently does not indicate the extent of internal injury. Physical signs have been of value in only a small number of the cases. The clinical picture may be obscured if the patient has taken excessive quantities of food and liquor. The same difficulty that is found in distinguishing acute alcoholism from those conditions in the abdomen requiring surgical intervention arises in thoracic injuries. In two instances, patients collapsed while being X-rayed. This was interpreted as internal hæmorrhage but operation revealed penetration and no hæmorrhage.

In three cases we observed a sign which we have never seen described. At a place about one to one and one-half inches caudad to the wound of penetration in the skin a ballooning occurred causing the skin to rise and fall with respiration. This billowy motion beneath the skin took place within an area one and one-half to three inches in diameter. There was no escape of air through the wound. We found this to be a true sign of penetration, since air must escape through the parietal pleura to cause it. A barrier of muscle prevented escape of air through the skin wound.

In 66 per cent. of cases, *i.e.*, sixty-nine out of 109, the X-ray picture taken pre-operatively indicated a pathological condition. In 25 per cent. of cases there was a shadow suggestive of hemothorax, although (as has been mentioned) one case proved to be a fibrotic or thickened pleura. In 11 per cent. of cases there were signs of hemopneumothorax and in one case pneumothorax unaccompanied by fluid. An interesting finding is the shadow produced by a wound in the lung itself by a bullet. This shadow remains discrete in the lung tissue and is surrounded by an area of aerated lung. In addition, there may be another shadow at a dependent portion indicating fluid in the free pleural cavity.

Implements of Penetration.—The commonest type of implement in our experience is the so-called "switch blade," a pocket knife with a long, narrow, strong, sharp and pointed blade. This may produce an apparently innocent external wound and yet do great damage beneath the skin. In comparison, the ordinary pocket knife is rather a harmless thing, which may penetrate the chest-wall, but seldom causes trouble beneath it. The ordinary table knife of broad blade, partially stopped by the ribs, frequently does less

PENETRATING STAB WOUNDS AND BULLET WOUNDS OF THE CHEST

damage than might be expected. The ice pick, which is occasionally used, unless it has struck the heart, is least harmful.

Bullets do more damage than stab wounds but fewer cases are brought to the hospital because death occurs so rapidly that the victims cannot be reached in time for treatment.

Wounds.—The abrasion at the edge of the bullet wound tells the direction from which the bullet came. A wound of exit may also help to indicate what visceral injury has occurred. On the contrary, stab wounds, however, give no sign of the direction of the laceration of the chest-wall. We have carefully studied the contour of stab wounds in order to determine before operation the direction of the path of the knife, but we were unsuccessful. Our operative procedures have taught us that stab wounds usually enter the pleura at a point caudad to the wound of entrance in the skin (indeed, sometimes a distance of two ribs below). When produced by a right-handed

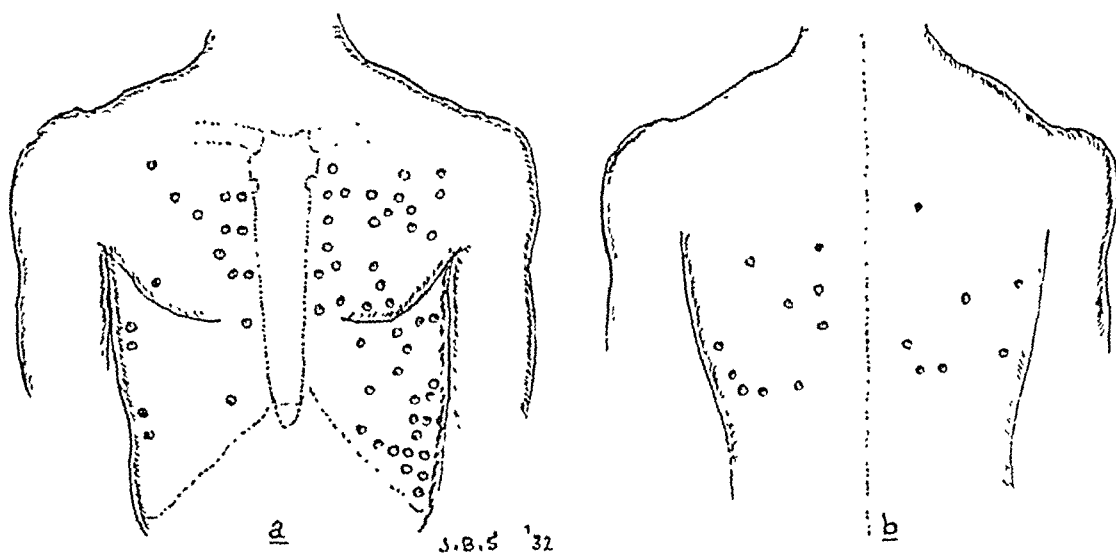


FIG. 1.—Anterior (a) and posterior (b) distribution of penetrating wounds. Note the frequency of penetration over the dangerous parasternal and diaphragmatic areas.

assailant the wound will proceed from the assailant's right to left. In making our exploratory incision we disregard the wound of entrance in the skin, and incise at a level an inch or an inch and a half below it. Wounds made in this manner produce incisions at different level of skin and pleura, and thus create a valve which may account for the infrequency of sucking wounds.

Wounds may be "sucking" or bleeding profusely or emit foamy blood with respiration but in the majority of cases they are entirely "silent" and afford no clue to the underlying injury. However, in the second and third periods of our investigation we did not depend upon signs of penetration. All cases in which consent was obtained were operated upon.

In Fig. 1 is shown the distribution of wounds upon the chest-wall. Most of them are on the left side, as might be expected, since most assailants are right-handed and the victim presents the left anterior chest-wall and axilla to the assailant. The distribution of wounds has, of course, an important rela-

tion to underlying structures. The majority are in such a position that the weapon may reach the internal mammary artery, the heart, or the diaphragm.

A stab wound in the pleura is frequently larger than the corresponding wound in the skin. It may be twice or three times as large. Some assailants penetrate the chest and then, with a motion of the wrist, rock the blade back and forth. This is one of the reasons why the skin incision offers no clue to the damage beneath it. A costal cartilage or the rib near it may be completely severed by a subcutaneous knife cut. A knife may hit the sternum and cause a wound which appears innocent because the sternum is directly beneath it, and yet the knife may have slipped from the sternum through the cartilaginous portion of the rib or between the ribs.

Complications and Causes of Death.—In our study the most valuable information that we have gained has been from observations and analysis of complications and from a study of the causes of death. By these data and by the practical method of being confronted with abnormalities at operation which required correction, we have been able to arrive at our present procedure.

Mechanical Factors.—(1) *Sucking Wounds.*—The ill effect of sucking wounds is well known. The embarrassment of circulation and respiration is terrifying. Equally striking is the immediate relief usually obtained by stoppering the orifice. But even when a sucking wound has been stoppered an intra-thoracic disturbance may have already taken place and progress to such an extent that the patient's margin of safety is diminished.

The disturbance of the mediastinum plays a part during life which cannot be given as a cause of death by the Medical Examiner since it usually cannot be recognized on post-mortem examination. The mechanism may be observed by the surgeon upon entering the chest cavity, as he sees the heart and the great vessels and the lung flap without rhythm. He may see the patient stop breathing and see the heart stop beating unless the mediastinum has been steadied by traction on the lung. If the heart stops and respiration ceases, steady traction on the mediastinum by grasping the lung may restore function.

Even when it has been closed a wound may break down as a result of infection and then it is impossible to close it. This infection may be brought about primarily from without or may result from an infected hemothorax dissecting its way from within.

(2) *Subcutaneous Emphysema.*—Subcutaneous emphysema or crepitation occurred in 40 per cent. of our cases. In all but four cases it was accompanied by penetration. It varied in extent from an area two inches in diameter to one involving the entire trunk, arms, and head. There was no trouble except in one case, in the first period. In this instance the air producing the subcutaneous emphysema issued from an intercostal stab wound and spread rapidly over the body above the waist line and in the mediastinum and caused alarming interference with breathing and swallowing. There were dyspnoea and cyanosis and death appeared imminent. However, after closure, by suture, of the intercostal muscles, the spread of the emphysema

PENETRATING STAB WOUNDS AND BULLET WOUNDS OF THE CHEST

was stopped and the patient went on to a perfect recovery. This was the only case since June 1, 1930, that required operative interference on account of subcutaneous emphysema. No palliative treatment of multiple skin incisions was made but the cause was attacked and removed.

(3) *Pneumothorax*.—In all penetrating wounds of the chest varying degrees of pneumothorax occur. In most cases it is small and of no practical importance. In our pre-operative X-ray examinations we found it present in only 12 per cent. of the cases. Routine examination by means of the pneumothorax apparatus during our second period demonstrated that it was usually present. In many cases in which the X-ray film showed no pneumothorax, the actual reading of the pressure in the chest showed variations from normal, usually a low negative pressure. Obviously the negative X-ray film does not rule out the presence of small amounts of air in the pleura. When post-operative readings were made during our second period, they were made in order to determine the possible existence of a tense pneumothorax. At present, we seldom find it necessary to measure the intra-thoracic pressure because a tense pneumothorax cannot occur when we have exteriorized the wounded lung. Whenever it occurred we were able to relieve it by employing the pneumothorax apparatus and removing measured amounts of air until the desired pressure was attained.

Negative X-ray films may be due in part to the fact that the pneumothorax is localized anteriorly or posteriorly as a result of adhesions and therefore it may not be revealed in the anteroposterior or postero-anterior films. It is possible that the films have been exposed when the lung temporarily filled the pleural cavity. In one case pneumothorax occurred on the side of the stab wound, but careful dissection showed no penetration into the pleural cavity. In another case pneumothorax was found in the side opposite to the stab wound.

A tense pneumothorax may be a serious condition, causing marked discomfort and even end in death. A pneumothorax may cause disturbance not only by tension, but may also contribute to a subsequent pneumonia. This occurs, we believe, in the following way:

The lung on the side of penetration is frequently completely collapsed and the opposite lung is partially collapsed because of the shift in the mediastinum. The compressed or collapsed lung has a deficient circulation and therefore is easily infected. Death may follow easily from the toxæmia of infection, because the compression and collapse have greatly diminished the amount of available aerated lung.

In a case complicated by a large hemothorax, a pneumothorax was superimposed through infection of the blood in the chest with a gas-producing bacterium, and gas with the odor of hydrogen sulphide was aspirated.

A pneumothorax does not occur, of course, in those cases in which the pleural cavity has been obliterated by adhesions of a previous inflammatory process such as empyæma. Percussion and auscultation were not very

dependable in the diagnosis of pneumothorax in our traumatic cases and we depended rather upon thoracentesis.

(4) *Hæmorrhage*.—Bleeding from the chest-wall occurs from the superficial blood-vessels and from the intercostal and internal mammary arteries. The first source is of no clinical importance since it produces at worst a large hematoma. Bleeding from the internal mammary and the intercostal vessels may be very troublesome, and, indeed, cause death by large hæmorrhage into the pleural cavity. Severance of the internal mammary vessels is far more dangerous than injury to the intercostals.

The heart in four cases, the pericardium in two cases, the lungs frequently, and the diaphragm in one case, were the sources of much intra-pleural hæmorrhage.

Massive hæmorrhage from the lung occurred frequently in our second period as demonstrated by the fact that in cases in which we had securely tied the intercostal vessels and emptied the pleural cavity of blood, a large hemothorax developed subsequently. In no case did we crush the intercostal vessel against the rib, as has been suggested, but after rib resection we ligated the vessel and placed packing down to it.

We have observed bleeding from the lung even after it was completely collapsed. We have realized the possible ill effects of allowing blood to remain in the pleural cavity where it may produce pressure or become the seat of infection, and we always attempt to remove all of it at operation.

It is not uncommon to find no signs of hemothorax even upon aspiration of the chest and yet after the struggle during the induction of anæsthesia an operation may reveal that a large hemothorax has developed. Frequently blood in the pleural cavity accumulates to such an extent that it exerts sufficient pressure to prevent further bleeding, and the patient may recover. If the blood is not aspirated, the hemothorax may become entirely absorbed or become organized with partial collapse of the lung. Frequently, if the collection of blood is not large, a single aspiration that is done for diagnostic purposes seems to occasion rapid absorption and disappearance of the hemothorax.

In the course of a hemothorax fever is frequently found ranging between 101° F. and 102° F., and may disappear spontaneously. A hemothorax may become infected. In one case, part of the hemothorax became purulent while another part was clear on gross examination. There was a wall of clot between them.

In entering for the purpose of exploring a pleural cavity in which a massive hæmorrhage has taken place, great care must be exercised. In one of our cases, a sudden large operative incision into the pleural cavity produced immediate cessation of respiration, a phenomenon familiar on occasion in cases of empyæma.

Hemoptysis.—Hemoptysis is a rare occurrence. Even in many of the cases in which on exposure large lacerations of the lung with broad bleeding surfaces were found, hemoptysis did not occur. In fact, it occurred only

twice in our entire series of cases, one in which the patient was stabbed with an ice pick and the other in which the patient had a diffuse pulmonary tuberculosis dating from childhood.

(5) *Infection*.—Infection played an important rôle in the second period in which as a rule only the chest-wall was repaired. In the third period infection played a minor rôle.

(a) *Chest-wall*.—Infection of the chest-wall, while fairly frequent, was extremely mild except in one case in which there was a through-and-through bullet wound of the left chest and lung. In this case an intrathoracic injury was corrected but a phlegmon of the chest-wall led to sepsis and death one week after operation. Infections of the chest-wall may involve either the fascia, the periosteum, or the parietal pleura, but are so mild that they cause no fever and the patient may be ambulatory or return to work.

(b) *Pleura*.—We are impressed by the fact that infection of the pleura is not in itself an important cause of death. In our third period we instituted a new operative procedure and pleural infection took place in only 6 per cent. of the cases, whereas in the second period it took place in 20 per cent. of the cases. Rarely does it cause death of itself but acts as a factor in causing death when other factors have not been corrected. It may be introduced from without at the time the patient is stabbed. A dirty knife, unclean clothes and an unclean skin present three sources of bacteria.

Infection may come from the lung which has been lacerated and in which a suppurative process takes place, later infecting the pleural cavity. It may take place in case a chest-wound is sutured and later breaks down allowing bacteria to be introduced from the outside. Also, it may arise from infection which has grown rapidly in the blood of a hemothorax, in this way producing a pyothorax and a purulent pleurisy.

A differentiation should be made between an infected hemothorax or pleura and a true empyæma thoracis. The term empyæma thoracis should not be used, we believe, to designate an infected hemothorax. There are two different conditions and the difference is not purely academic. An empyæma thoracis originates in a superficial lung infection in individuals who usually become weak and anæmic as a result of long-standing infection. In infected hemothorax the patient usually has been robust and the lung is not the seat of primary infection and so he is able with ease to take care of the infected blood in the pleural cavity.

(c) *Lung*.—Although we believe that cases of late hemothorax may arise from infected lacerated lung, we have had only one opportunity to observe this phenomenon. The case will be described later.

Cerebral embolism was a post-operative complication in two cases. There was present coma and unilateral paralysis together with other symptoms of less importance clinically. In both instances the patient recovered, one symptom-free, the other with hemiparesis.

Visceral Injury.—*Heart*.—During the second and third periods, there were four penetrating wounds of the heart.

Diaphragm.—In the second period of thirty-two cases there were six cases of penetration of the diaphragm, five of which were repaired and one that was discovered at autopsy. In the third period there were five cases of penetration of the diaphragm and in one of the cases there were three lacerations. In none of our stab wounds did we find intra-abdominal injuries though the diaphragm was penetrated. On the contrary, in the bullet wounds penetrating the diaphragm, intra-abdominal injuries were found involving the stomach, small intestine, the liver, the spleen, the omentum, and the mesenteric vessels. In each case except one the diaphragm was successfully sutured. In three cases we extended the lacerations in the diaphragm and explored the upper portion of the abdomen on the left side through it. This, of course, is not advisable as a routine.

All the penetrating wounds of the diaphragm except one were on the left side. On the right side, lacerations of the diaphragm are of less importance because of the liver, which acts as a protecting barrier. One of the stab wounds which penetrated the diaphragm entered the skin at the level of the nipple and another one inch above the nipple.

Lung.—In the second period where only the chest-wall as a rule was operated upon, laceration of the lung was noted in only three cases in a total of thirty-two, while in the third period twenty-four cases of laceration of the lung were noted in a total of thirty-two cases. In this third period the lung in every instance was carefully examined for laceration while in the second period only a glimpse of the lung could be had through the small opening. The size of the lacerations varied from a superficial puncture to a laceration which extended from the border of the lung inward for a distance of three inches and involving its entire thickness.

Causes of Death.—The important factors causing death may be best demonstrated in a discussion of cases. The records in the first period, that is, before routine operations were introduced, show eleven deaths in forty-five cases. It is difficult to determine the exact cause of death in these cases because autopsies were not seen by us, and the examination of charts and records of patients who have not been observed personally is not reliable. However, the impression gained was that the majority of deaths was due to hæmorrhage while infection was of less importance.

In the second period (in which we were attempting to find a logical operative procedure) of thirty-two patients, seven died. And in the third period (in which our operative procedure, to be described later, was employed) there were four deaths among thirty-two cases.

In addition, during the second and third periods there were six cases without operation with one death, and four heart wounds with four deaths.

Causes of Death in the Second Period.—CASE I.—The patient was stabbed in the right second interspace close to the sternum. There was a massive hemothorax apparently arising from a severed internal mammary artery. The chest was rather suddenly opened through a large incision. The patient collapsed and in spite of a transfusion of 1,000 cubic centimetres of blood and an infusion of 3,000 cubic centimetres of physi-

PENETRATING STAB WOUNDS AND BULLET WOUNDS OF THE CHEST

ological saline solution, she died. The factors causing death were hæmorrhage, sudden opening of the chest cavity, with disturbance of the mediastinum, and recurrence of hæmorrhage.

CASE II.—There was a stab wound of the left anterior axillary line penetrating the diaphragm. The lacerations in the diaphragm and in the chest-wall were firmly sutured. The abdomen was explored through a separate incision and no injury was found. Three days after operation the patient developed pneumonia on the *right* side and died in two days. In this case the left lung at post-mortem was found completely collapsed. The pneumonia and subsequent death were favored by the pneumothorax, the collapse of the left lung, and compression of the right lung.

CASE III.—This patient had bilateral stab wounds. The intercostal vessels on each side were ligated, and the patient was quite comfortable until the sixth post-operative day, when he suddenly became dyspnoic, apprehensive, went into collapse and died. At autopsy a tense pneumothorax was found on the left side so great that the diaphragm and the liver were pushed down to the pelvis and air escaped with a hissing sound on section of the thorax. This patient died of the mechanical effect of a tense pneumothorax upon the lungs, the heart and the great vessels of the mediastinum.

CASE IV.—A stab wound penetrated the chest-wall in the left axilla and lacerated the left lower lobe. When the pleural cavity was entered, the lung collapsed, but bleeding continued from the lacerated portion. A mattress suture failed to stop the bleeding and therefore a free piece of muscle taken from the chest-wall was placed over the laceration and held in the place by a few sutures. Bleeding was controlled. The patient had an extremely easy convalescence until the twelfth post-operative day, when a slight hemoptysis occurred, followed in an hour by a massive hemoptysis and bleeding into the pleural cavity. Death occurred soon. At autopsy, in addition to the hæmorrhage, a small abscess was found in the region of the laceration of the lung. This abscess was due to infection from the assailant's knife. The infection spread in the parenchyma of the lung eroding the blood-vessels, dissolving the catgut sutures, and permitted free, profuse hæmorrhage.

CASE V.—This patient died of a huge intra-pleural hæmorrhage. The intercostal vessels at the site of the stab wound had been ligated but bleeding occurred from the lung filling the entire pleural cavity; the blood became infected, and death occurred.

CASE VI.—This is an extremely interesting case in which the laceration of the chest-wall was situated an inch above the left nipple. The intercostal vessels were ligated and the laceration of the chest-wall was sutured. The patient became progressively worse and two days later died. An X-ray examination a few hours before death showed fluid in the pleural cavity. Post-mortem examination showed a laceration in the diaphragm one and one-half inches long through which the fundus of the stomach had protruded. The protruding portion became constricted and gangrenous, and ruptured, discharging its contents and necrotic wall into the pleural cavity. In this case, because of the high position of the point of entrance of the knife, an injury to the diaphragm was not suspected.

CASE VII.—In this case a bullet penetrated the lung and diaphragm, perforating the stomach in two places and the small intestine in four. The chest-wall, the diaphragm, and the gastro-intestinal lesions were sutured and post-mortem showed all the sutures quite competent, with the peritoneum clean and glistening. There was, however, a pneumothorax on the left side, pneumonia in both lungs, and complete collapse of the left lung. The factors leading to death were the pneumothorax with collapsed lung on one side, and compressed lung on the other, forming a favorable basis for the pneumonic process.

In the *third period* there were four deaths in thirty-two cases. In each case the lung was attached to the chest-wall according to the method to be described.

CASE I.—Death was due to sepsis. Blood culture showed a growth of hemolytic streptococcus. There was found at autopsy a purulent pleurisy, mediastinitis, and a massive collapse of the lung. It is of interest that the collapse did not occur on the injured side (where the lung had been sutured to the chest-wall) but in the opposite lung.

CASE II.—This patient was shot through the left chest. Ribs were shattered in front and in back and fragments of bone were imbedded in the lung. (Fig. 2.) A through-and-through channel caused by the bullet was seen in the lung. At each orifice the lung was sutured to the chest-wall. The patient was able to cope with the pleural and pulmonary injury but succumbed seven days later to a sepsis arising from a phlegmon in the chest-wall where fragments of bullet and bone had remained.

CASE III.—A bullet traveled from the right costal margin in the nipple line, lacerated the liver, tore the vascular border of the stomach and perforated the diaphragm and chest-wall. (Fig. 3.) The chest cavity was entered first, blood aspirated, the hole in the diaphragm closed and the lung attached to the chest-wall. Through a separate incision in the abdomen the bleeding gastric artery was ligated and bleeding from the liver controlled by packing. Death was due to peritonitis, general sepsis and pneumonia.



FIG. 2.

FIG. 3.

FIG. 2.—This patient had a through-and-through bullet wound of the chest. The lung and pleura remained clear of infection but a phlegmon of the chest-wall containing bone and bullet fragments (which may be seen just to the outside of the safety pin) was the seat of a sepsis to which the patient succumbed.

FIG. 3.—A bullet lacerated the right upper lobe. The shadow is due to intrapulmonary hæmorrhage. There is no shadow of fluid (blood) in the lower portion of the pleural cavity because the pleural cavity is obliterated by adhesions due to an empyæma thoracis which occurred thirteen years ago. This was demonstrated at operation.

CASE IV.—In this case there were penetrating stab wounds of both sides, but only the side of severer injury was operated upon because the patient was in poor condition. The patient died twelve hours after operation. We were unable to ascertain the exact cause of death.

Because all these deaths were cases of homicide they came under the jurisdiction of the medical examiner. Except for the last case all the post-mortem examinations were seen by us personally. A careful demonstration was made in each case by Doctor Norris, Doctor Gonzales, or Doctor Helpern. The teaching was invaluable.

Analysis of Complications and Causes of Death.—The essential factors causing death and complications of penetrating wounds of the chest may be classified as follows:

PENETRATING STAB WOUNDS AND BULLET WOUNDS OF THE CHEST

(1) Hæmorrhage from the lung, from the intercostal and from internal mammary arteries.

(2) Infection involving the chest-wall, the pleura and the lungs.

(3) Mechanical factors due to sucking wounds, pneumothorax, subcutaneous emphysema, and to the relaxation of the normally stabilized mediastinum.

(4) Visceral injuries involving the heart, lungs and diaphragm.

DEVELOPMENT OF THE NEW OPERATIVE PROCEDURE

Although our original object in operating upon each case during the second period was to ligate bleeding intercostal or internal mammary arteries, we discovered during our explorations other injuries and corrected them.

Thus in the case of Ethel A., a bleeding lung was encountered. (Figs. 4A and B.) It was sutured. We were mindful, however, of the case in which a sutured lung became infected and bled profusely at the place of suture. To avoid a repetition of this unfor-



FIG. 4A.

FIG. 4B.

FIG. 4A.—Case of Ethel A. This is a röntgenogram of the first case in which extrapleurization and exteriorization of lacerated lung was performed. The film one day post-operative shows the left lung attached to the chest-wall at the place of suture with a pneumothorax above and a small amount of fluid in the costophrenic sinus. The extensive scars of tuberculosis are present.

FIG. 4B.—Case of Ethel A. Seven days post-operative. Pneumothorax and hemothorax have disappeared. The cavities of a chronic fibroid tuberculosis are present in both upper lobes.

fortunate occurrence the lung was anchored to the chest-wall at the site of the exploratory incision. We contended that if the lung were to bleed externally, it could then be controlled by packing. After this was done we realized also that any possible purulent collection that might develop in the lung would empty through the hole in the chest-wall without contaminating the pleura. A post-operative X-ray picture in this case showed the lung attached to the chest-wall, partly aerated. Five days later the lung was completely expanded, and although there was diffuse bilateral pulmonary tuberculosis, the patient made an uneventful recovery.

The next case to be admitted was that of Leo B. (Figs. 5A and B.) His assailant perforated his chest-wall from the first to the fifth intercostal space, completely severing the cartilages of the second, third, and fourth ribs, causing a huge hemothorax and a through-and-through laceration of the lung which admitted three fingers. The patient was in marked collapse and several times during the operation he ceased to breathe and once his heart stopped. Each time a gentle, firm pull on the lung restored function. Small sections of cartilage were removed in order to allow for intrathoracic exploration.

Intercostal arteries were ligated. The lacerated portion of the lung was removed and a raw surface remained presenting an area about three and one-half long by one and one-half inches in width. Bleeding from this raw area was controlled by chain sutures. Since the restoration of respiration and of circulation was obtained during the operation by pulling upon the lung and thus stabilizing the mediastinum it occurred to us that permanent stabilization of the mediastinum might be obtained by fixing the lacerated lung in the wound of the thoracic wall by suture. This was accomplished by a continuous suture, interrupted at intervals. At the same time the lung when sutured into the wound acted as an excellent stopper and prevented sucking.

Thus in this case with a single operative procedure we were able to stabilize the mediastinum, care for the lacerated lung, take care of the sources of



FIG. 5A.



FIG. 5B.

FIG. 5A.—Patient Leo B. The entire wound was produced by the assailant. The tissue in the centre of the wound is the lacerated lung which has been sutured into the wound.

FIG. 5B.—Patient Leo B. The wound is completely healed by scar tissue. There is no hernia of the lung.

hemorrhage (the intercostal arteries and the lung), stopper the large hole in the chest-wall, prevent infection from entering the pleural cavity, and allow whatever infection might remain in the lacerated lung to be exuded.

The completeness of this operation in caring for so many important complications caused us to employ it in all cases except in one case in which a bilateral hemopneumothorax was produced by multiple ice-pick wounds. It is this operation of exteriorization of the lacerated lung which was performed upon all the cases, thirty-two in number, in the third period of our series.

The Operative Procedure.—(Figs. 6, 7 and 8).—The patient is brought

PENETRATING STAB WOUNDS AND BULLET WOUNDS OF THE CHEST

to the operating room by way of the X-ray room. Röntgenograms are made in each case except those which show marked constitutional collapse.

The anæsthesia of choice is avertin, 100 milligrams per kilo of body weight. Frequently it has been necessary to reënforce the anæsthesia with ether, preferably by the open cone and drop method. Early in our series we employed ether without avertin, or gas and oxygen without avertin, to which the patient, as a rule, responded poorly, thrashing about, vomiting, increasing the bleeding, and frequently aspirating vomitus. This was distressing to witness and then when the chest was opened there were violent excursions of the diaphragm and lung, and the mediastinal structures flapped irregularly and vigorously. With avertin, however, the lungs moved slowly and

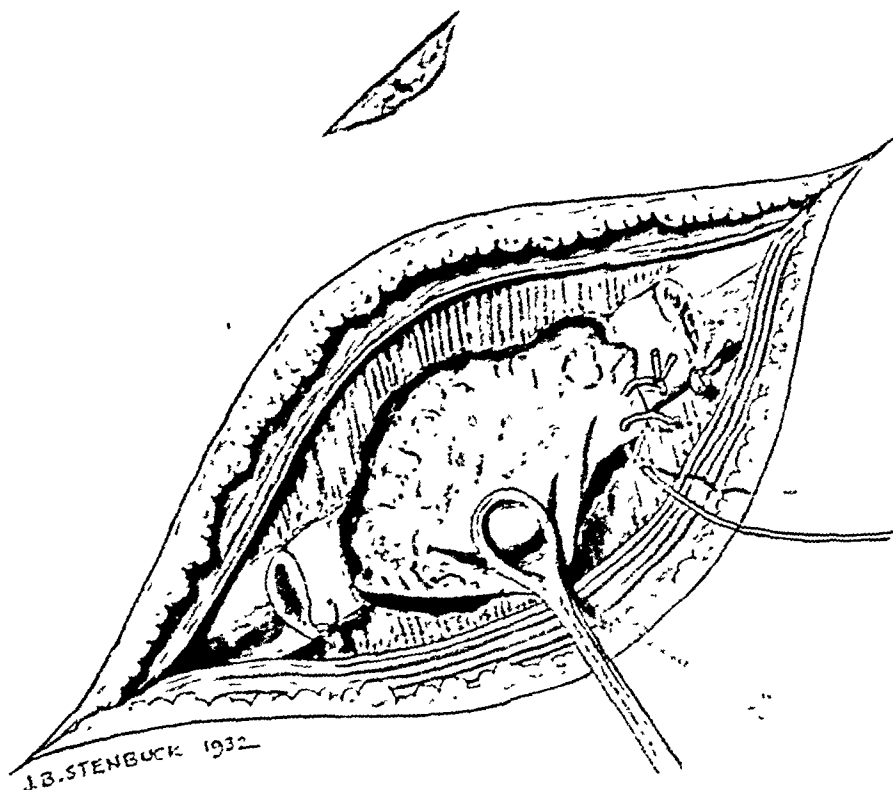


FIG. 6.—Operative procedure. The lung is grasped with a sponge forceps so that the lacerated portion is included. The lung is then sutured, beginning at the lower border, to the chest-wall. Note that the rib has been removed back far enough to allow for soft tissue to which the lung may be sutured. The skin wound of penetration is shown above the operative wound. It is not treated.

quietly and the heart was seldom disturbed. It was much easier for the patient and the surgeon.

While the patient is being anæsthetized physiological salt solution is introduced intravenously and 300 to 500 cubic centimetres are allowed to run in slowly. If the patient requires little in the way of operative procedure or if the wound is found to be non-penetrating, no further saline is given. When necessary, however, up to 3,000 cubic centimetres have been given on the operating table. Sometimes the saline is given merely as a preliminary to transfusion, which is given with citrated blood introduced into the infusion bottle after the saline. We have been fortunate in being able to secure blood

for transfusions whenever necessary and often so quickly that, with the coöperation of Dr. S. Weintraub and Doctor Nach, transfusions were given before the end of the operation.

The patient is placed upon the operating table with the wound uppermost. After preparation of the skin with tincture iodine and draping with sterile sheets, the wound is probed with a cotton applicator dipped in tincture iodine. In this way the direction and extent of the wound may be determined. The tract is not excised but an incision is made over the region where the pleura has been penetrated, which is usually an inch or more lower than the skin wound. The chest muscles, the pectorals or latissimus dorsi, are divided by blunt dissection if possible, and by sharp dissection if necessary in order to

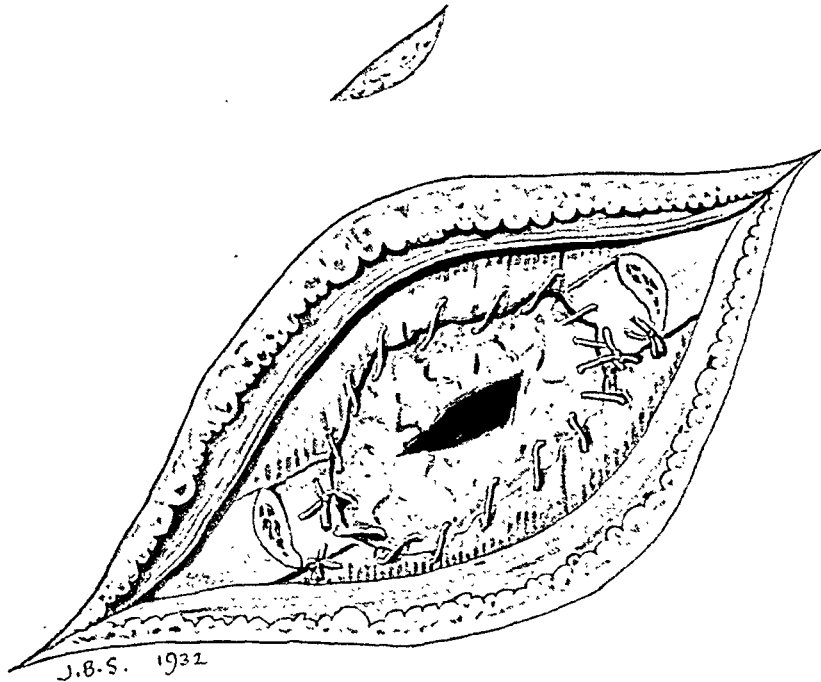


FIG. 7.—Operative procedure. The lung has been sutured to the chest-wall producing an air-tight closure of the pleural cavity and causing the wound in the lung to present externally. This is the operation of "extrapleuralization" and exteriorization of lung and laceration.

reach the hole in the pleura. About two or three inches of rib are removed subperiosteally. The rib selected is the one from which the intercostal muscle has been severed by knife or bullet. A rib denuded of the attached intercostal muscles cannot be employed later in the operation because we then require soft tissue to which to suture the lung. For the same reason the ends of the rib at the place of resection are rongeured so that no rib end overhangs the pleural orifice. In this way a ledge consisting of parietal pleura, periosteum, and muscle is formed.

The intercostal vessels are ligated on either side of the wound, which is then enlarged in order to permit exploration of the pleural cavity. Immediately upon entering the cavity the lung is grasped and held up to the chest-

PENETRATING STAB WOUNDS AND BULLET WOUNDS OF THE CHEST

wall in order to maintain mediastinal equilibrium and at no time during the operation is the lung allowed to recede to the mediastinum. Manipulating with sponge forceps, the lung is examined and if a laceration is found the lung is grasped so that the lacerated portion is held within the jaws of the forceps. Blood is aspirated if present in the pleural cavity, exploration is continued, and any further damage repaired. In case of diaphragmatic perforation, particularly by a bullet, a separate abdominal incision is necessary and should be made for exploration.

Lacerations of the lung vary in size and shape. There may be first, a simple penetration part way into the lung tissue, second, a through-and-through laceration, and third, a laceration starting at the border and running

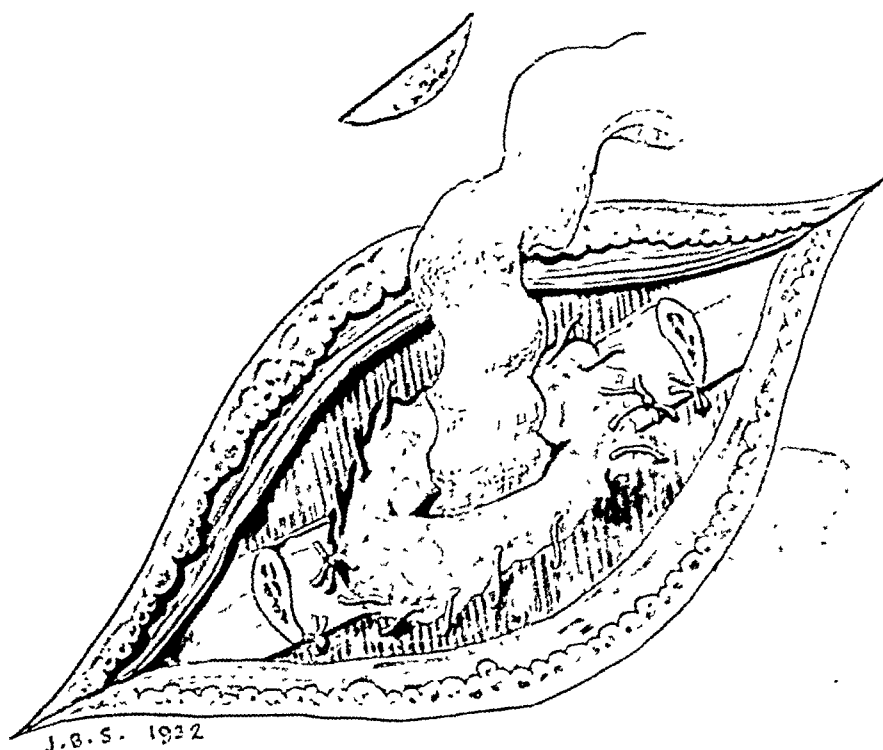


FIG. 8.—Operative procedure. Gauze is inserted loosely into the laceration and around the line of suture and the skin is sutured over it. Where there is no laceration in the lung it is nevertheless sutured to the chest-wall and gauze is placed along the line of suture.

toward the hilus, producing a V-shape laceration. In each case we have brought up the lung to the chest-wall in such a fashion that all the lacerated tissue is exteriorized and is extrapleuralized by means of suture. In the through-and-through lacerations they may be exteriorized as such, or, if necessary, may be converted into a V-form and thus may be more easily exteriorized.

The lung is held with a forceps so that the lacerated portion is in the centre of the hole in the chest-wall. The lung is then fixed to the chest-wall by a continuous suture (interrupted at either end). The lower edge of the orifice is sutured first because if the upper edge is first attached we usually find insufficient lung with which to work below because of retraction. Iodoformized gauze packing is inserted into the pulmonary laceration. We do

not close a laceration in the lung because of the great possibility of the development of infection. More gauze is packed around the suture line and beneath the chest muscles at the edge of the wounds. The skin and muscles are sutured tightly over the gauze packing, which is allowed to remain *in situ*, for four or five days.

Even when not lacerated, the lung is attached to the chest-wall, if the chest-wall has been penetrated. This obviates the bad effects of a pneumothorax particularly as regards the mediastinum and is a rapid way of closing the orifice in the chest-wall. Lilienthal, in his *Thoracic Surgery*, vol. ii, p. 548, reported a case in which by means of pneumopexy he successfully closed a large defect in the chest-wall. In no case have we seen a hernia of the lung follow the operation, although we have had lung to the extent of two and one-half inches in diameter present itself uncovered.

The Advantages of Exteriorization and Extrapleuralization of Lacerated Lung.—The advantages of our operative procedure may be summarized as follows:

(1) Blood and infectious material are allowed to drain from the lung away from the pleural cavity.

(2) The mediastinum cannot flap nor become displaced since it is held fixed by a steady pull through the lung which has been attached to the chest-wall.

(3) Pneumothorax is diminished in size.

(4) The lung is prevented from complete collapse and aerated because, being attached to the chest-wall, it must move with respiration.

(5) Subcutaneous emphysema is not produced because air from the lacerated lung can go only to the outside of the chest-wall.

(6) A tense pneumothorax cannot be produced for the same reason.

(7) Infection does not enter the pleural cavity from without because the pleural cavity is sealed off.

Although we have employed this procedure of attaching the lung to the chest-wall only in cases of penetrating wounds, we feel certain that its range of usefulness is much wider. From our observations patients in whom the lung was sutured to the chest-wall had an easier convalescence and lower death rate than those in whom it was not done. We presume, therefore, that in any type of case in which the chest-wall is opened (except, of course, in the presence of gross infection) the patient's chances of recovery are enhanced by the operation which we have described. It is preferable to insufflation of the lung just before closing the chest-wall. In those cases in which this was done our post-operative X-ray film frequently showed extensive pneumothorax although we thought the lung had been fully expanded before closure of the chest-wall.

In cases of combined intrathoracic and abdominal injuries with perforation of the diaphragm we have found it advisable always to enter the chest first in order to repair damage and gain the advantage of attaching the lung

PENETRATING STAB WOUNDS AND BULLET WOUNDS OF THE CHEST

to the chest-wall. The diaphragm can more easily be repaired from above and the patient can better bear the abdominal operation after the lung and mediastinum have been stabilized. If the abdomen is entered first, the hole in the diaphragm may allow air to enter the pleural cavity, thus allowing for an increased pneumothorax and increased compression of lung and consequent disturbance of the mediastinum.

Post-operative Treatment.—The patient, if extremely sick, is transferred immediately to an oxygen tent or preferably to the oxygen chamber, but if his condition is fair oxygen is employed by nasal cannula. Oxygen therapy has been applied with the close coöperation and the direction of Dr. J. G. M. Bullova, of the Medical Service. We employ supportive treatment when necessary similar to that used in other surgical cases.

It is not necessary to re-insert packing into the lung after the first removal, indeed, in one case in which the lung was repacked possibly too firmly the suture line was broken in part and permitted infection of the pleural cavity from without, producing a purulent pleurisy. The patients remain in bed for a period of eight to ten days. The length of time varies, of course, with the condition of the patient. There have been no late sequelæ due to operation.

OUR PRESENT MANAGEMENT OF CASES OF PENETRATING WOUNDS OF THE CHEST

In our study we tried not only to perfect an operative procedure, but also to find, if possible, what cases required operation and what cases might be watched and treated for symptoms as they should arise. While we operated upon all cases during the second and third period of our observations, we realized fully that many cases may recover without operation. We have learned, however, that under certain circumstances, waiting may prove disastrous and therefore that operation is advisable, *viz.*:

(1) In cases of sucking wounds. The mechanical disturbance of lung and mediastinum should be corrected. If treated early with the operation of extrapleuralization of the lung, the sucking wound even if contaminated causes no disturbance, but if not so treated after the wound is infected the sucking cannot be controlled.

(2) In cases of wounds close to the sternal borders where the heart and the internal mammary vessels may be injured. The hæmorrhage from the mammary vessels is usually severe and may be rapidly fatal, for though they are anatomically extrapleural, practically they are intrapleural and as a rule bleed directly into the pleural cavity. Moreover, the tissues with which these vessels are in contact are not soft and yielding, but being fixed, permit only slight retraction and closure of the severed vessels. It must be remembered too, that when the artery or vein is cut bleeding may occur from either side because of the anastomosis.

(3) In cases in which the lung presents itself in the open wound. With

some respiratory exertion the lung may slip back into the pleural cavity even though on admission to the hospital it was fixed in the hole in the chest-wall. If it does slip back we are then presented with the problem of a sucking wound.

(4) In cases in which penetration might involve the diaphragm. Penetration of the diaphragm is not uncommon and may occur in wounds entering the chest anywhere below the fourth rib. On the right side no operative interference is necessary for repair of penetration of the diaphragm such as occurs in the average stab or bullet wound because the liver acts as a perfect stopper. On the left side, however, penetration of the chest and diaphragm carries with it the danger of perforation of stomach, intestines, and spleen and bleeding from mesenteric vessels. A perforation of the diaphragm may present no symptoms until late. When its existence is suspected operation should be undertaken immediately.

(5) In cases of tense pneumothorax. If on manometric reading there is positive pressure in the pleural cavity operation is advisable because it is not likely that the lesion which causes the tense pneumothorax will spontaneously subside. One may, however, temporize by removing air from time to time. We have found that for this purpose a pneumothorax apparatus is best since a measured amount of air may be removed, and a measured intrapleural pressure may be obtained.

(6) In cases of marked subcutaneous emphysema. Subcutaneous emphysema may spread to the neck and mediastinum producing marked difficulty in swallowing and in breathing. When these difficulties arise, the valve-like formation in the lung or chest-wall permits air to enter but not to leave the subcutaneous tissues with respirations. This may be corrected by exteriorizing the lung at the place of penetration in the chest wall.

If the injuries do not fall into one or more of these classifications at present we employ expectant treatment. If there is hemothorax or pneumothorax or both without any of the complications described above we depend mainly upon observations with the X-ray and with the pneumothorax apparatus. X-ray pictures are taken upon admission and again in five hours. This is an arbitrary period but we find it helpful. If there is increasing fluid, operation is performed. Otherwise the patient is observed further. If repeated pneumothorax readings show increasing positive pressure, operation is performed. While, as a rule, two days may be considered a safe period after which a hemothorax will not increase, a pneumothorax may become tense even as late as a week after injury. On this account intrapleural pressure readings should be taken at intervals for a week.

CARDIORRHAPHY IN WOUNDS OF THE HEART

BY MICHAEL MAMIKONOFF, M.D.

OF BAKU, U. S. S. R.

FROM THE SURGICAL SERVICE OF THE BLACK TOWN HOSPITAL OF BAKU

PREVIOUS to January 1, 1928, cardiorrhaphy had not been done at the Black Town Hospital at Baku, although the literature of surgery had already chronicled more than 600 cases. (Wagner; Mukhadze.)

We can now present three personal cases, two cases of stab wound, and a third case of gunshot wound. We have also made two exploratory pericardiomies which failed to confirm a presumptive diagnosis of heart wound. Of these last cases one died on the operating table; the other recovered.

The characteristic symptoms of internal hæmorrhage were displayed by these patients: extreme pallor of skin, cold extremities and absence of pulse in peripheral vessels. In all three cases the operation demonstrated that a wound of the heart was the cause of the hæmorrhage. In the two last cases the pericardium was distended with blood. The first case was published in the monthly "Vestnik Hirurgii," vol. XIV, 1928.

CASE I.—A student, aged twenty-four, was admitted to the surgical section January 7, 1928 (Fig. 1A), with a stab wound in the second intercostal space to the left of breast; he was pulseless. Resection of second, third and fourth left ribs and of a part of breast was done under local anaesthesia. Transpleural pericardiotomy was done by Mamikonoff. A stab wound was found in the wall of the right auricle. The wound was sutured with two sutures. A tight suture was applied to the pericardium. Fixation of the lung to costal pleura. Drainage of pleural cavity. Slow recovery. February 22, 1928, patient exhibited at Baku Surgical Society. March 8, 1928, left hospital.

CASE II.—A man, aged twenty-eight, admitted August 22, 1931 (Fig. 1B), with stab wound on the left breast nipple; pulseless. Resection of fourth and fifth left ribs was done under ether narcosis. A great quantity of bloody fluid distended the pleural cavity. Transpleural pericardiotomy (Mamikonoff) revealed a stab cut of the left ventricle with profuse hæmorrhage from the wound. The heart wound was sutured. The pericardium was caught imperceptibly in the suture. Resection of pericardium. Additional sutures to bleeding heart wound. A tightly closing suture on pleura. August 23, bradycardia, dyspnoea, general condition very serious. Twenty hours after operation a repeated thoracotomy was done and 300 grams of blood extracted from the pleuro-pericardial cavity. Fixation of lung to the costal pleura. Again a tight suture on pleura. September 12 to 29 patient feverish. Puncture in the eighth intercostal space, left side below scapula; pus discharged, September 30, resection of eighth rib opened a limited abscess of pleural cavity. November 10 patient left hospital.

CASE III.—Man, aged twenty-four, admitted September 16, 1923 (Fig. 1C), wounded two hours before admittance by an accidental shot. General condition very serious. Pallor of face and chilled extremities. Pulse on radial arteries appeared from time to time. A small bloody spot under left nipple. Transpleural pericardiotomy and cardiography was done under ether narcosis (Mamikonoff), through a cut twenty centimetres in length, running parallel to ribs at the left of breast. Resection of sixth and seventh ribs. The wounded pleura was distended with much blood; the pleuro-pericardial septum was greatly infiltrated with blood and had not the usual pulsation of heart. A transverse

pleuro-pericardiotomy gave vent to four large clots from the pericardial cavity, followed by a flood of bloody fluid. A wound, one cubic centimetre, half covered by a thrombus, was disclosed on the front wall of the right ventricle. Past the thrombus a thin flow of blood was escaping. The heart wound was rapidly sutured with a thick silk suture which cut through; second suture with the same result. The wound opening of heart, doubly enlarged, was controlled by the pressure of the hand of the operation nurse. A large piece of the pleuro-pericardial septum was cut out and the wound opening of the heart sutured with it with five sutures which controlled the hæmorrhage. By two additional side cuts the opening of the pleuro-pericardium septum was enlarged upward, and the heart carefully examined. No hæmorrhage. Pleuro-pericardial septum straightened and left unsutured. The lung fixed to costal pleura. A tight suture on pleura. Dressing. Physiological solution and digalen under skin; ice on wound.

Till September 20 pulse obscure, temperature high, dyspnœa. September 22, 750 grams of bloody fluid extracted from the cavity of left pleura. September 27, pulse irregular, rapid and uneven. October 2, *status idem*. Röntgen examination showed a



A

B

C

FIG. 1(A).—First patient operated on January 7, 1928. (B)—Second patient operated on August 22, 1931. (C)—Third patient operated on September 16, 1932.

great accumulation of fluid in the proper pericardial space, and displacement of heart to the right. Puncture of pericardium gave vent to 10 cubic centimetres of turbid fluid, admixed with broken-down tissue. Analysis of fluid proved the fluid as sterile. September 6, general condition much better. Fall of temperature. October 18, a control examination by röntgen-rays shows a dark aspect of the left lung apparently resulting from the thickening of pleura. Less fluid in the saccate pericardium space than during previous examination. Left half of diaphragm is by three fingers breadth higher than the right one, and does not absolutely exercise. The heart is 25 centimetres to the right from right sternal line. According to the röntgen plate, the bullet is lodged in the wall of the left ventricle.

October 23 the patient left hospital in satisfactory condition and healed wound, after being exhibited with the two previously operated patients at the conference of Baku Surgical Society, October 20, 1932 (Fig. 1).

According to literature data in nearly all cases of heart wounds operation has consisted (a few exceptions) in suturing of wound opening of the heart. But the effect of the operation is not the same in all cases. L. Rehn,³ Fridrich

CARDIORRHAPHY IN HEART WOUNDS

Hesse¹ and Constantini,¹⁷ each having operated on six patients, lost one of them. J. J. Grekoff¹⁹ has three cases of recovery out of six cases of cardiorrhaphy (last operation for a bullet embedded in the heart); while Bardenheuer does not succeed in saving one of his five patients, operated upon in connection with heart wounds, and Dshanelidse² loses four of his eight patients subjected to cardiorrhaphy. Muchadse²⁰ collected out of Russian literature thirty-two cases of operation on heart wounds performed at various points in the U. S. S. R. during the last ten years; in twelve cases death ensued. Such great difference in results of cardiorrhaphy cannot be assigned to the technics of operation exclusively, but to various conditions characterizing each individual case, *i.e.*, in other words, to numerous individual peculiarities of each case.

CHARACTERISTICS OF OUR PATIENTS

- (1) Stab wound on the right auricle. Patient pulseless.
- (2) Stab wound on the apex of heart (left ventricle). Patient pulseless.
- (3) Blind gunshot wound on the right ventricle. Pulse appears at times.

Examining statistics and comparative data in the literature, we find the following:

According to Fisher, out of 452 cases of heart wounds not subjected to operation, twenty-two were gunshot wounds on the wall of right ventricle, fifty-nine stab wounds on the left ventricle and eleven stab wounds on the right auricle. These data are based on autopsy-confirmed material.

According to Dshanelidse, of 535 operated heart wounds, there were fourteen cases of gunshot wounds on the right ventricle, 167 stab wounds on the left ventricle, and thirty-seven stab wounds on the right auricle. One hundred forty-seven patients out of 491 had no pulse to be felt in peripheral vessels; Erich Hesse¹ cites forty-eight cases of heart wounds at Obukhoff Hospital, of which only four were gunshot wounds. There were fourteen cases of injuries of the right ventricle, twenty-six of the left ventricle and four of the right auricle. Fifteen patients had no pulse on peripheral vessels.

These data can, in some way, play a guiding rôle in the treatment of heart wounds by operation. It proves namely that the ventricles are more frequently subjected to operation; gunshot wounds bring patients to the operation table less frequently; stab wounds are more often met at the operation table, and the great bulk of patients appear on the operation table pulseless.

Early operative interference is an exceptionally important factor in cardiorrhaphy. In three cases of Erich Hesse's, where death ensued, operations were performed fourteen hours after wounding, *i.e.*, when patients were quite bloodless. In regard to this, Hesse declares, after studying heart wounds in forty-eight cases of cardiorrhaphy, that "only an early operation guarantees success." And, indeed, our patients have undergone operation six to two hours after wounding, *i.e.*, during a comparatively favorable period of time. Only the first patient, brought to the operation table six hours after wounding, quite bloodless, did not show any signs of life during three days following the

operation, and was lying as dead. Even his diuresis was limited to 30-140 grams of urine during these first three days. Therefore, it would seem that all wounded soldiers with heart injuries have to remain on the battlefield, if they are not subjected to an early operation. In connection with this Ballance¹⁰ writes that numerous cases of hæmopericardium and extrapleural hæmorrhage perished on battlefields ere first aid could be administered. According to Ludwig Rehn's³ data, based on German material from the World War, there were cases—and not unfrequent—when previous heart wounds were discovered during the secondary admittance of wounded soldiers to the hospital. This fact proves an exceptional tenacity of the heart as to wounds. Therefore, operations on heart wounds charge the surgeon with an immense responsibility for careful adherence to all cardiorrhaphy rules and, first of all, to the most elementary rule—irreproachable asepsis, breaking of which is up to date the cause of death in 50 per cent. of all cases. And, indeed, salvation of wounded depends on aseptic suturing of heart wound. Infection introduced during the wounding of the heart does not constitute a specific danger.

Prompt and careful stoppage of hæmorrhage is an important factor in technics of operative interference. In our third case suturing of the heart wound was met by exceptionally unfavorable anatomical conditions. The third of our patients was the youngest of the three, but his sutures cut through the muscular tissue of the heart. This usually happens with aged persons or those who indulge in alcohol. According to Erich Hesse's data, cutting through of sutures happened in eight cases out of forty-eight cardiorrhaphies. All except two of these eight patients died. Those two were saved by closing the heart wound with resected pieces of pericardium. In my case the heart wound was compressed, after cutting through two sutures, by the hand of the operation nurse, while I cut out a piece of pericardium and succeeded in carrying out the last stage of the operation in my third case probably owing to *situs cordis superficialis* (according to Sauerbruch),^{12, 13} which greatly facilitated transplantation of pericardium, performed without an assistant. It seems that later the edges of the transplanted piece of pericardium underwent partial necrosis, which was proved by analysis of fluid extracted from the pericardial space by means of puncture. It is necessary to emphasize a very important circumstance observed only with the third patient, namely, a partial covering of the wound opening of the heart by thrombus. A high thin flow of blood streamed past thrombus from the cavity of the right ventricle. All the operation personnel present at the operation were able to observe hæmorrhage direct from the exposed heart. As to the heart activity during the suturing, it is necessary to mark that we were unable to distinguish movements of systole from diastole in all our three cases. Assertions by some of the necessity to suture heart wounds during systole, and of others during diastole, are probably either results of experimental observations on animals, or theoretical reasonings, resulting from the fancy of surgeons, who suffered a severe nervous strain during performance of cardiorrhaphy. Pleura and pericardium drainage question is settled each time individually.

E. Hesse,¹ Grekoff,¹⁰ Zavialoff, Bländ-Sutton, Müller and many others prefer tight suturing of pleura and pericardium. According to the literature data of Dshanelidse, both serous bags were sutured tightly in 145 cases: recovery in eighty-five cases, while of eighty-five cases treated by drainage of pleura and pericardium, there were only forty-one cases of recovery.

Our first patient was subjected to operation with tight suturing of pericardium and drainage of pleural cavity. But the other two patients were operated on with tight suturing of costal pleura, and in both cases a wide connection was left between pleura and pericardium cavities; in the second case, as in the third, pleura pericardium septum was not sutured at all for fear to compress the heart in the reduced pericardium bag. In all our three cases of transpleural pericardiotomy the lung was fixed by sutures to costal pleura.

In our second case we were forced to open the pleura twice after cardiorrhaphy: the first time twenty hours after the cardiorrhaphy to evacuate the bloody fluid from pleuro-pericardial cavity; second time, thirty-five days later, to empty a limited pus exudation of the pleural cavity. In our third case we were obliged to empty in turn both serous cavities by puncture. My three cases confirm the superiority of tight suture, which corresponds to literature data. Besides other advantages, a tight suture gives patients a possibility to avoid frequent dressings and consequently lessens the danger of reinfecting serous cavities. According to Jehn's data, resulting from observations during the World War, a tight suture on the pleura led to 90 per cent. cases of recovery, while conservative treatment of injured pleura (pneumothorax) led to death in 90 per cent. of all cases. The latter method was applied by German surgeons at the beginning of the World War. (Jehn.)

In all three cases of transpleural pericardiotomy performed without an apparatus for increased lung pressure, we had dislocations of thoracic organs, namely, displacement of mediastine, a partial lung collapse and dislocation upward of the left half of diaphragm immediately after the operation. Traces of this pathology in the topography of the thoracic organs still persisted when the patients left hospital. Even now the left half of the diaphragm of all three cardiorrhaphied patients is higher than the right one and does not move in excursion.

Basing on the two last cases, where integrity of pleuro-pericardium septum was not restored, we may conclude that the even connection between pleural and pericardial cavities may not have serious consequences, provided a hermetic closing of thorax and fixation of lung to costal pleura is carried out.

Some words about foreign bodies embedded in the heart: location of the bullet in the walls of the heart was not my task while suturing the heart wound in the third case. L. Rehn considers that only those foreign bodies in the heart which move freely in its cavities must be subjected to extraction. Such alien bodies can penetrate into the aorta or pulmonary artery and provoke most serious complications. Borst cites two such cases. In one of them a bullet caused aneurism of pulmonary artery, and injury of aorta with formation of fistula between both vessels and death. Klose^{4, 5} notes from the literature seven cases of bullets and fragments passing from the heart cavity into

the aorta and pulmonary artery, in four of which death ensued. Foreign bodies which are fixed to the endocardium are not subjected to extraction, provided there are no special symptoms. Such fixed foreign bodies are usually covered by interstitial membrane and do no harm later.

In one case (J. Hiss) a shell fragment passed through the left ventricle and embedded itself in the wall of the right ventricle. As a result pericarditis, endocarditis, an insufficiency of the bicuspid valve; recovery. Müller was forced to operative interference in connection with heart compression, as blood streamed into the pericardial cavity. During the operation, performed three hours after wounding, it was found that the heart wound did not bleed any more. A bullet, lodged in the front wall of the right ventricle, was not extracted; recovery. J. J. Grekoff explained his operation; ventriculotomia explorativa cordis, by the fear that a bullet could pass into the pulmonary artery. This hypothesis was caused by rotating movements of the bullet in the right ventricle cavity as röntgen examination proved. At examination of our third patient November 21, 1930, a keen systolic murmur could be heard at the apex; pulse was 126 a minute. By the time the patient left the hospital all these abnormal phenomena had disappeared, giving place to a healthy physiological heart activity. In all our three cases of operative exposure of the heart we applied the method of final rib resection, that greatly simplified later on our task of pericardium puncture to which our last patient was subjected November 2.

In spite of the seriousness of heart wounds and of the numerous unfavorable conditions usually accompanying such wounds, all our patients (except the third) are at present doing their work. The last patient, though not bedridden, is still an invalid.

BIBLIOGRAPHY

- ¹ Hesse, E.: Vestnik Chirurgie (Russian), vol. iv-vi.
- ² Dshanelidse, I.: Ibid. (Russian), vol. xiv.
- ³ Payr, Ervin, et Franz, Carl: Handbuch der Aertzlichen Erfahrungen im Weltkriege, 1914-1918. Band I. Ludwig Rehn.
- ⁴ Klose: Archiv f. klin. chirurgie, Bd. 124.
- ⁵ Klose: Ibid., Bd. 126.
- ⁶ Wagner: Ibid., Bd. 134.
- ⁷ Wagner: Ibid., Bd. 143.
- ⁸ Bier, Braun, Kümmel: Bd. II.
- ⁹ Trudi: XVII Siesda Chirurgon, U. S. S. R.
- ¹⁰ Ballance: Surgery of the Heart. London, 1920.
- ¹¹ Zeidler: Beiträge klin. chir., Bd. 89.
- ¹² Sauerbruch: Chirurgie der Brustorgane, Bd. II, 1925.
- ¹³ Sauerbruch: Archiv f. klin. chir., Bd. 133.
- ¹⁴ Dshanelidse: Rani serdtsa., 1927.
- ¹⁵ Smith: Zentralorgan f. d. gez. chir., Bd. XXVI. (Report.)
- ¹⁶ Vance: Ibid., Bd. XXXII. (Report.)
- ¹⁷ Constantini: Ibid., Bd. XXXII. (Report.)
- ¹⁸ Lees: Drug sdravia, 1837. (Russian.)
- ¹⁹ Grekoff: Vestnik Chirurgie (Russian), vol. xvi-xvii.
- ²⁰ Muchadse: Ibid., vol. xvi.

JEJUNOSTOMY

A CLINICAL AND EXPERIMENTAL STUDY OF THE TECHNIC OF THE OPERATION *

By W. HOWARD BARBER, M.D.

OF NEW YORK, N. Y.

FROM THE DEPARTMENT OF SURGERY, UNIVERSITY AND BELLEVUE HOSPITAL MEDICAL COLLEGE
AND BELLEVUE HOSPITAL, THIRD SURGICAL DIVISION

JEJUNOSTOMY is generally agreed to be a useful procedure although its indications are not generally accepted. On the Third Surgical Division, Bellevue Hospital, it has been a practice to perform jejunostomy in certain inoperable ulcers and growths of the stomach and in a small percentage of acute inflammatory conditions of the abdomen in which the normal intestinal peristalsis is seriously disturbed. In the course of this work, certain apparently inexplicable instances of mortality have occurred. In the considerations of these fatalities,¹ it did not seem that the operative procedure was misapplied nor did the theories on the cause of death appear satisfactory. Hence this attempt has been made to supplement the clinical observations by further examinations under experimental conditions with the hope of presenting the most probable causes of human failure after jejunostomy.

Jejunostomy may be looked upon as temporary and requiring the use of a tube, or permanent and not requiring a tube.

The method most frequently employed in this series covering the past thirteen years, or from 1920 to 1932, has been the (tube) method of Witzel. The operation, almost always an emergency, has been carried out in one stage. A soft rubber catheter, 18 to 25 F., is introduced within a loop of jejunum, 20 to 30 centimetres from the duodeno-jejunal flexure, through a small cautery stab or incision. The tip of the catheter is sutured to the margin of the intestinal wound with fine chromic gut and inverted with a purse-string of the same material. The tube is directed caudad while the next remaining 5 centimetres is laid against the antimesenteric wall of the intestinal loop and inverted with continuous or interrupted Lembert sutures. This stomatized loop is then sutured to the peritoneum and fascia of the abdominal wound and the wound is closed about the tube.

From an examination of the table of the hospital cases (Table I) it is evident that eleven of the twenty lived two weeks or more (possibly as long as the life expectancy in extremely advanced gastric malignancies), and that nine died within two weeks. The records of the early cases did not disclose the pathology of the stomatized loop, the duodenum, omental fat, or peritoneum. Obstructive symptoms, excoriation, and catheter troubles are commented upon. The elimination of the tube, even for a few hours, may have relieved a few of these patients from duodenal obstruction. On the other

* Read before the New York Surgical Society, October 12, 1932.

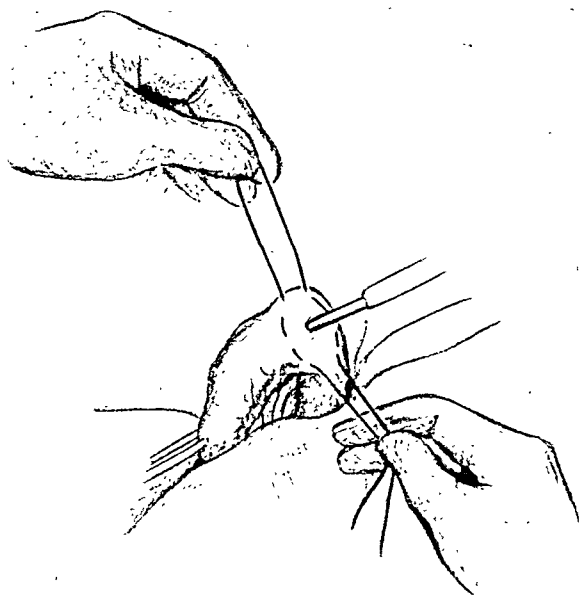
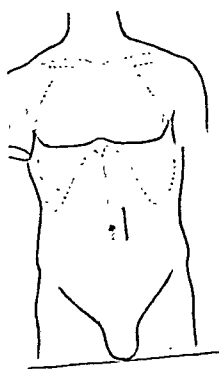
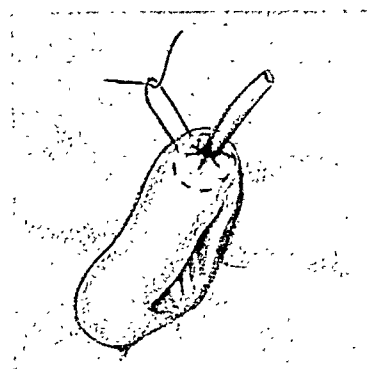
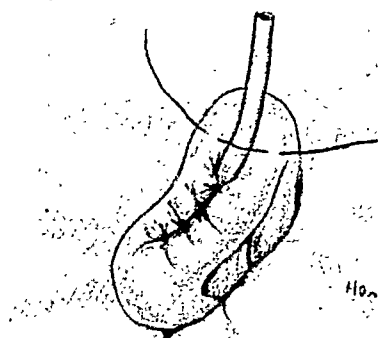


FIG. 1.



A.

FIG. 2.



B.

FIG. 3.



FIG. 4.

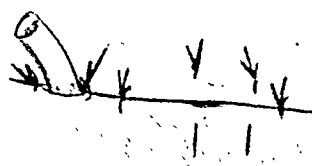


FIG. 5.

FIGS. 1, 2, 3, 4 and 5.—Jejunostomy as performed with tube and omentum interposed. Omentum was not mobilized about tube in the hospital series.

JEJUNOSTOMY

hand, if the tube is to be easily replaced, it seems necessary to replace it at once. With few exceptions the technic was that described above.

The author has repeatedly used omentum as a buffer against leakage about the catheter within the peritoneum as is done in ileostomy with success without realizing its dangers until observations had been made in the experimental series. (See Tables II and III.)

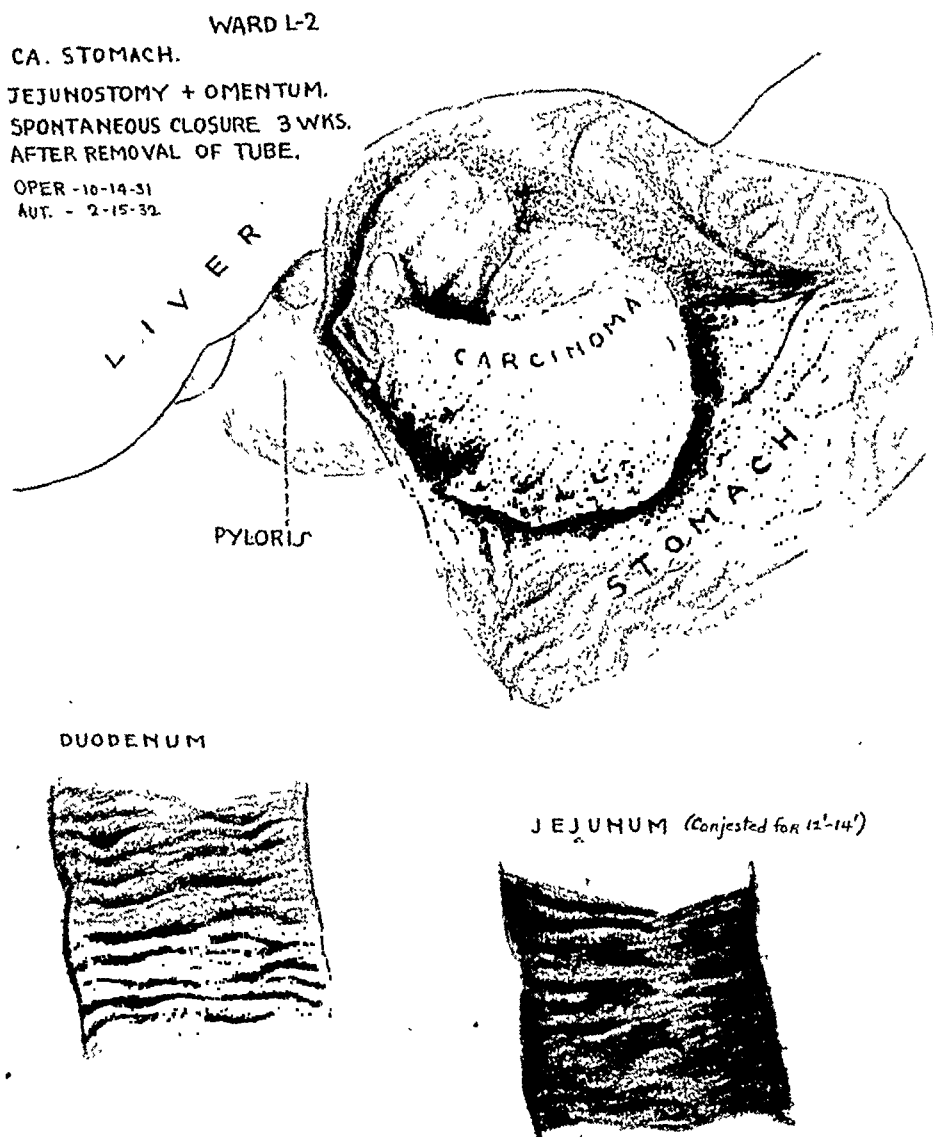


FIG. 6.—L. C. (See Table I.) Necropsy findings in clinical jejunostomy (with omental grafting) for inoperable carcinoma of stomach. Lived fairly comfortably four months. Jejunostomy closed spontaneously after passage of tube. Note especially the hæmorrhagic jejunum and normal-appearing duodenum. This jejunitis was thought due to irritation from feedings, disturbed secretions, and trauma from catheter.

Extract from post-mortem report, L. C., February 15, 1932.—The duodenum appears natural except for a moderate amount of congestion of the mucosa. The papilla of Vater appears natural. About 1 foot from the fossa of Treitz the mucosa of the jejunum is markedly hæmorrhagic. At this point the jejunum is adherent by a rather firm band of adhesions to the anterior abdominal wall at the site of the incision. This hæmorrhagic area extends the entire extent of the jejunum and the first part of the ileum. This section of the bowel contains a watery red-colored fluid. In the remainder of the ileum the mucosa appears natural.

These experiments have been performed upon dogs carefully prepared and anæsthetized with morphine and sodium amytal. Operations were carried out upon electrically heated tables. Fluids were administered by hypodermoclyses, by jejunostomy, and by mouth. It was not practicable to collect

TABLE I

Temporary Jejunostomies as Performed in Bellevue Hospital (3d Surg. Div.) Series, 1920-1932, Including Inoperable Carcinomata of Stomach

| Case No. | Post-operative Das. | Technic | Unfavorable Post-operative Findings |
|-----------|------------------------|--------------------------------------|--|
| V. 1, 22 | 60 | Witzel; peritoneal fixation | Diarrhoea |
| V. 1, 31 | 7 | Witzel; peritoneal fixation; drain | Leakage |
| V. 1, 32 | 15 | Witzel; peritoneal fixation; drain | Distension; difficulty in retaining tube |
| V. 1, 33 | 14 | Witzel; peritoneal fixation | ? |
| V. 2, 81 | 43 | Witzel; peritoneal fixation | None reported |
| V. 2, 103 | 0 | Witzel; peritoneal fixation | Died same day |
| V. 2, 104 | 23 | Jejunostomy | Distension |
| V. 2, 106 | 25 | Jejunostomy | ? |
| V. 2, 119 | 1 | Witzel | Intestinal obstruction (?) |
| V. 3, 120 | 15 | Witzel | Difficulty in retaining tube; leakage |
| V. 3, 125 | 12 | Witzel; peritoneal fixation | Difficulty in retaining tube; leakage |
| V. 3, 127 | 7 | Witzel | Difficulty in retaining tube |
| V. 3, 131 | 63 | Jejunostomy; peritoneal fixation | Leakage |
| V. 4, 177 | 9 | Witzel; omental interposition | Intestinal obstruction |
| V. 4, 192 | 1 | Witzel | Intestinal obstruction (?) |
| S. S. | 20 | Stamm-Kader; muscle-peritoneal graft | Difficulty in retaining tube |
| F. C. | 2 | Witzel; peritoneal fixation | ? |
| L. C. | 120 | Witzel; omental interposition | Difficulty in retaining tube |
| L. J. | 30 | Witzel; peritoneal fixation | ? |
| F. C. | 2 | Witzel; peritoneal fixation | Intestinal obstruction |

TABLE II

Experimental Table Showing Effects of Omental Interposition in the Witzel and Stamm-Kader Technics

| Experiment Number | Duration in Das. | Technic | Findings † |
|----------------------|---------------------|---------|--|
| J. 1 | 2 | S-K | Leakage. Omentum suppurative. Peritonitis. Mic.: duodenal erosions, cellular infiltration |
| J. 2 | 2 | W | Obstruction. Duodenum dilated. Jejunum congested, especially invaginated wall. Mic.: duodenal erosions, infiltration. Jejunal-capillary dilatation of mucosa. (See drawing.) |
| J. 3 | 10 | W | Obstruction and peritonitis. Leakage. Duodenum dilated, eroded, congested. Jejunum congested, especially invaginated wall. Omentum hæmorrhagic, suppurative. (See drawings.) |
| J. 4 | 6 | W | Leakage. Adhesions incomplete. Peritonitis. Omentum suppurative. Obstruction. Duodenum and jejunum congested, especially invaginated wall. (Cf. drawing.) |

JEJUNOSTOMY

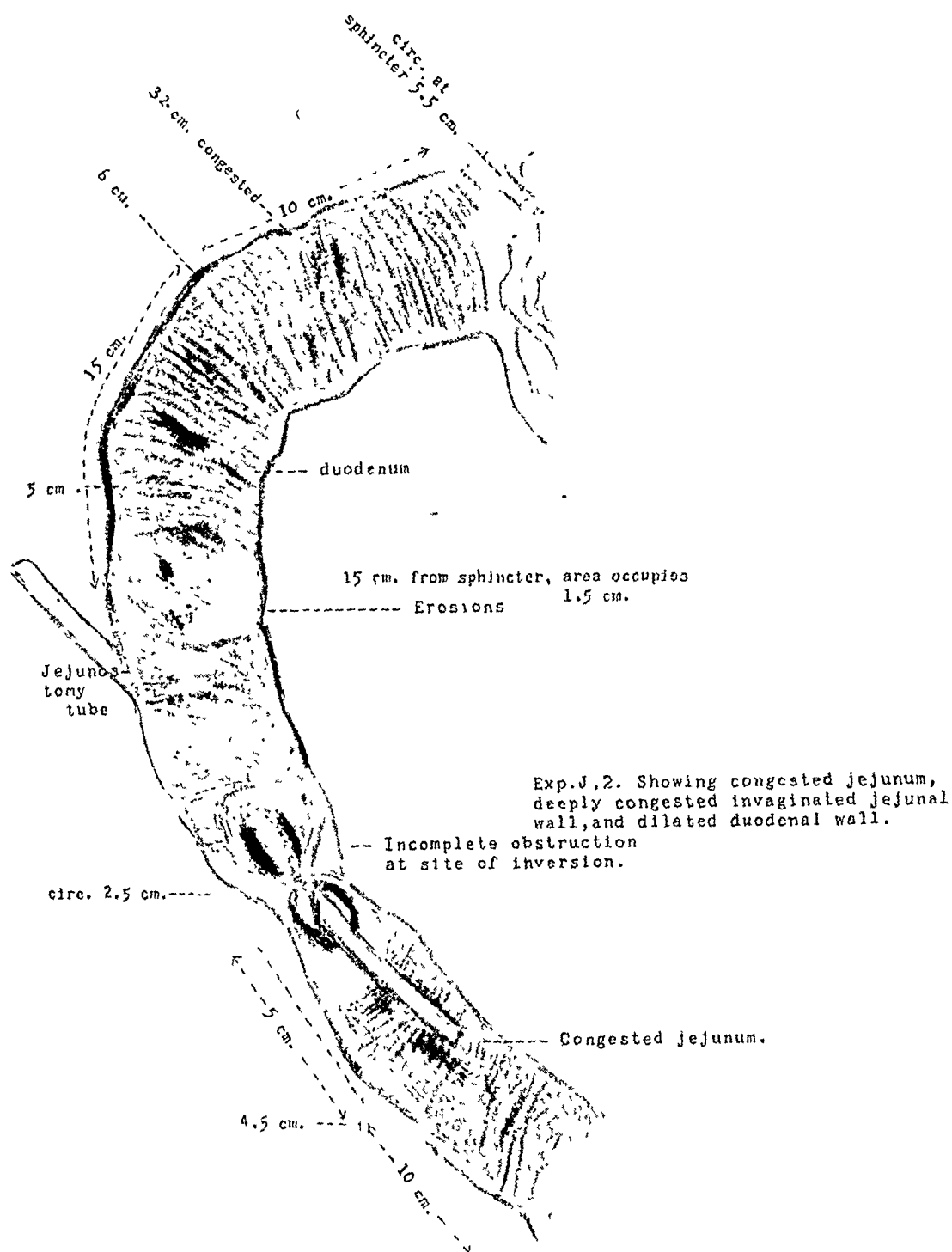


FIG. 7.—J-2. (See Table II.) Early obstructive changes following jejunostomy.

FIGS. 7, 8, 9, 10, 11 and 12.—Drawings illustrating experimental jejunostomy with tube and superimposed omentum as carried out in a few selected hospital cases. For convenience, the purse-string principle is referred to as "Stamm-Kader" or "S-K" and the invagination of the tube as "Witzel" or "W."

TABLE III

*Experimental Table Showing Omental Factor and Influence of Gastrojejunostomy upon External Jejunostomy**

| Experiment Number | Duration in Das. | Technic | Findings † |
|-------------------|------------------|------------------------|--|
| J. 5 | 6 | No Omentum GE W. | Adhesions firm. Obstruction slight. Duodenum and jejunum normal |
| J. 6 | 3 | Omentum GE S-K | Leakage. Peritonitis. Adhesions incomplete |
| J. 7 | 5 | Omentum GE S-k | Leakage. Peritonitis. Adhesions incomplete |

TABLE IV

Experimental Table Showing Results of Peritoneal Coaptation in Jejunostomy

| Experiment Number | Duration of Experiment Das. | Technic | Findings |
|-------------------|-----------------------------|---------------------|---|
| J. 9 | ? | S-K | Adhesions firm; omentum, duodenum, jejunum normal. Invaginated jejunum wall congested. (v. drawing.) |
| J. 10 | 2 | Witzel | Adhesions firm; incomplete obstruction; invaginated jejunum wall necrotic. (v. drawing.) (Mic.: Necrosis at sutures; jejunum congested, superficially necrotic and infiltrated) |
| J. 11 | 2 | Witzel | Peritonitis and obstruction |
| J. 20 | 2 | Witzel (no tube) | Gas infection of wound |
| J. 21 | 19 | Autolytic Stitch | Adhesions firm; stoma clean-cut; No inflammation |

* Cf. drawings of J.4 and J.5.

† Attention is called to microscopical changes observed in duodenal and jejunal loops after jejunostomy. These changes, it will be noted, correspond with those already reported after simple obstruction by Hartwell, Hogue, and Beekman (*Arch. Int. Med.*, vol. xiii, p. 701, 1914). Superficial cellular necrosis, erosions, and leucytic infiltrations predominate in the duodenal loops and, vascular congestion, although present in the oral loops, is almost invariably present to some degree in the jejunal loops. This congestion centres about the jejunal stoma and diminishes caudad but involves the adjacent two feet of the intestinal mucosa. Autopsied human specimens indicate more extensive involvement in long-standing cases that have gone without careful medical (dietetic) supervision. The thromboses and gangrene, described by Van Beuren (*ANNALS OF SURGERY*, vol. lxxii, p. 610, 1930) do not apply excepting in respect to the invaginated jejunal wall in certain instances after the Witzel technic which shows necrosis from terminal vascular occlusion. These findings harmonize with the gross appearance of the tissues.

JEJUNOSTOMY

and administer the gastroduodenal secretions during the first two post-operative days and introduce them with the feedings as the author has done in the human cases, but the helpfulness of these digestive juices in the jejunal loop is indicated by the tissues of the dog jejunostomized after gastrojejunostomy. (See Table III, Experiment J.5.) Blood chemistries were carried out in five of the animals before and after operations. Greenwald, who very kindly made these determinations, reports a tendency in all of the animals toward

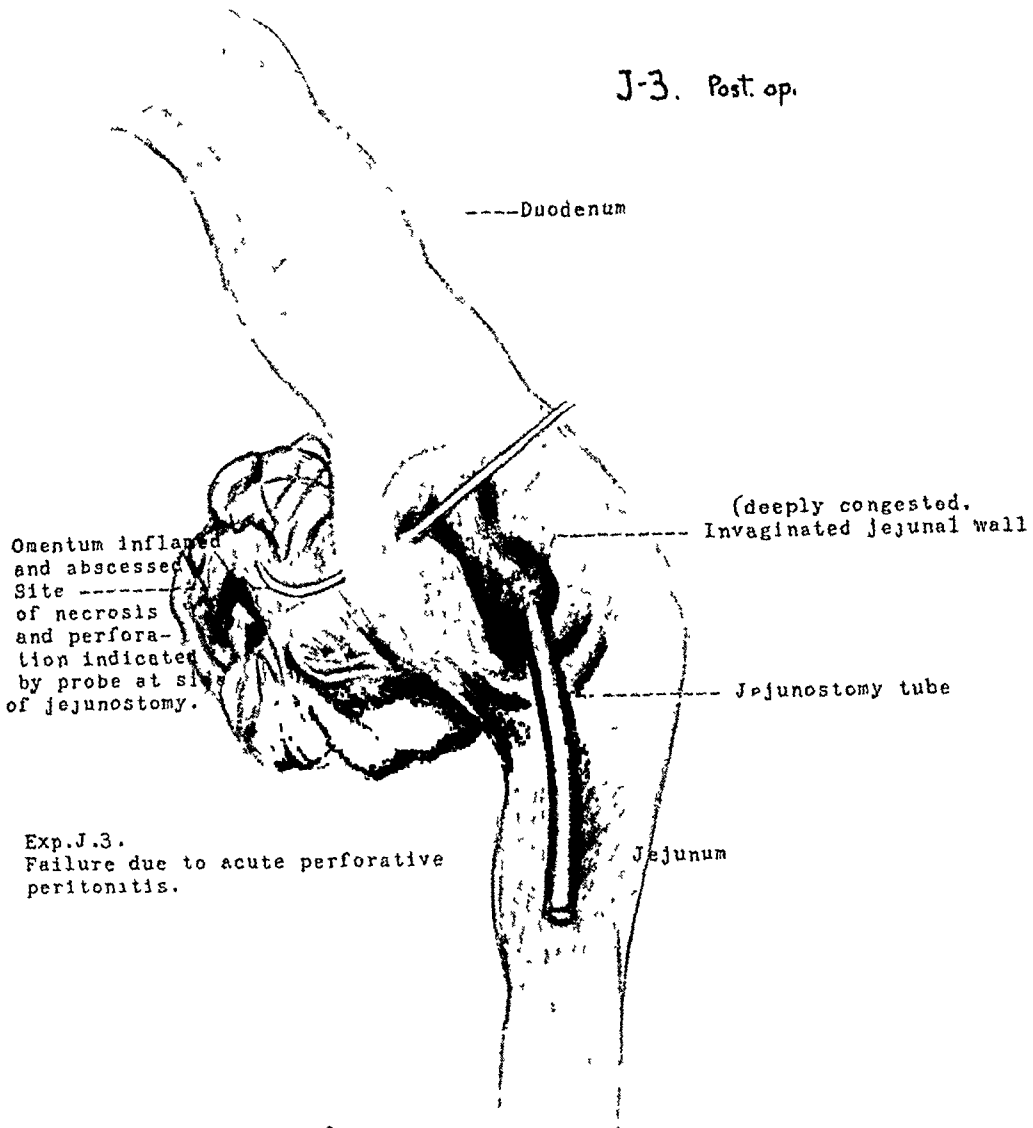


FIG. 8.—J-3. (See Table III.) Omentum acutely inflamed. Invaginated jejunal wall deeply congested. Adhesions not sufficient to protect peritoneum.

nitrogen retention similar to that of the duodenally obstructed animals. The operative technics have been modified in the successive animals to meet the indications disclosed by the respective autopsies. The first four were operated by the Witzel method with the exception that omentum was left between the stomatized loop and the parietal peritoneum. This method was compared with a modified Stamm-Kader technic with interposed omentum and both technics were compared without omentum. Finally, the method was evolved

which appeared to meet the indications of intraperitoneal leakage and peritonitis. (See Tables IV and V.)

It is necessary at this point to digress in order that one may be prepared for the difference in the productive inflammation about the jejunostomy tube in those instances in which peritoneal surfaces are brought directly in con-

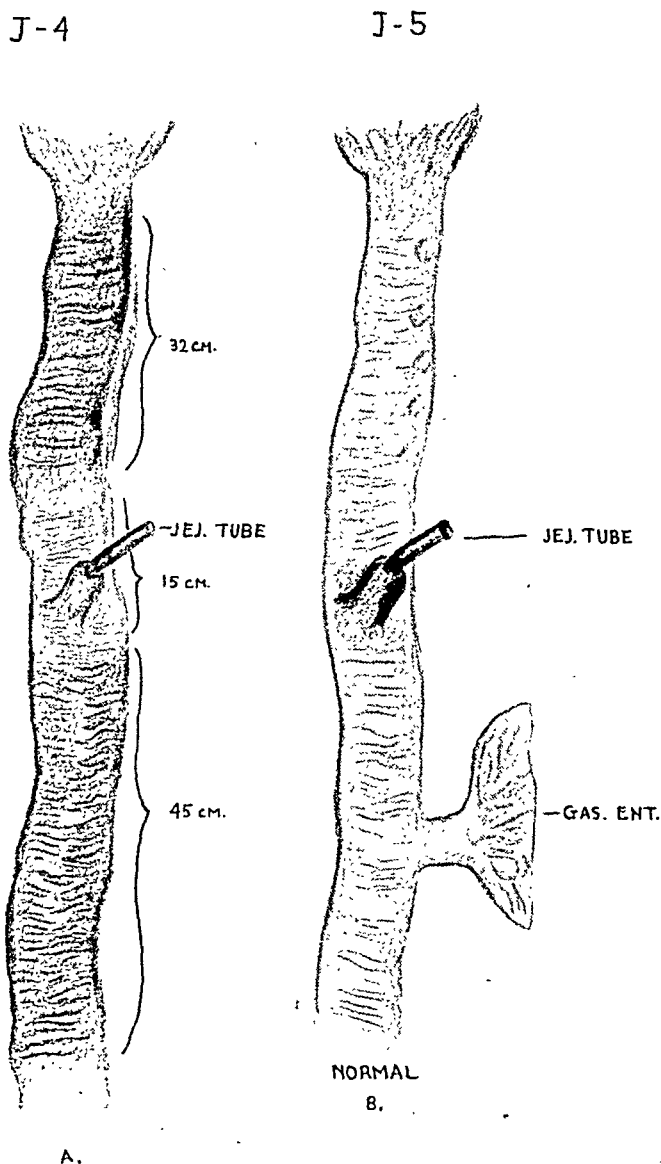


FIG. 9.—J-4. (See Table II.) Duodenitis and jejunitis and peritonitis following jejunostomy and omental grafting. Mucosal changes essentially due to obstruction at tube site. J-5. (Table III.) Normal duodenum and jejunum following technic similar to J-4, but with gastroenterostomy added.

tact, and in those in which omentum is left between the visceral and parietal peritoneum. It has been repeatedly found that the adhesions between the peritoneal surfaces are more firm and better organized, while those between omentum and peritoneum are less firm and at one site about the tube deficient. This deficiency inevitably allows enteric contamination of the adjacent omen-

JEJUNOSTOMY

tal and visceral surfaces and leads to acute peritonitis. The fat of the omentum or falciform ligament takes on a bright red color, much more pronounced than the smoky red injections of the serosal surfaces. In a few cases fat necrosis, as observed in pancreatitis, was observed. The inference naturally follows that the peritoneum is more resistant than fat to the seeping fluid from the jejunum.

These findings are believed to be in accordance with clinical experience after the method of jejunostomy outlined above for the hospital series. Co-Tui has shown that the trypsin content of the small intestine varies inversely with the distance from the pylorus, and that the amount in the oral jejunum is many times that in the terminal ileum. Furthermore, in apposing living

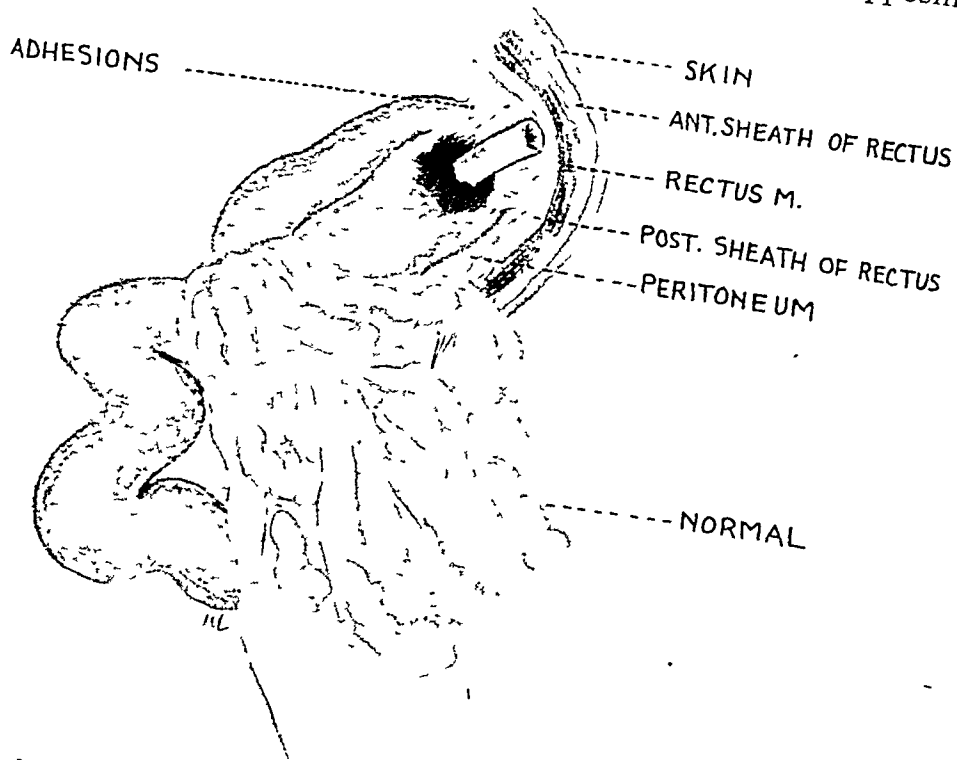


FIG. 10—J-9 (See Table IV) "S K" technic with peritoneal coaptation. Note adhesions (firm) and normal viscera. Congested inverted wall only. Pathological finding due to operation

tissue to inert rubber tubing it is evidently impossible to produce or to maintain a water-tight or leakage-proof connection so that "seepage" of trypsin-containing material is inevitable. During the first few hours, if organization of the exudate about the tube within the peritoneum can proceed, peritonitis will have been averted and leakage will be carried out on to the abdomen. In one instance the leaking fluid attacked the subcutaneous fat and produced necrosis in this layer well out upon the chest and abdomen. (See Table IV, No. J.20.) This experience suggests the precaution of protecting the subcutaneous fat with sutures, perhaps by suturing skin to fascia, in closing the abdominal wall or of leaving the stomatized loop or loop-catheter long and anchored a distance from the wound. Although the omentum has been used

in jejunostomy as it is commonly used in ileostomy, experimental observations seem to indicate that the stoma about the indwelling catheter should be carefully peritonealized first before attempting to "tuck" the omentum about the suture line.²

The accompanying experimental tables and illustrations indicate the presence of firm adhesive strands in the "peritoneal coaptation" series and the loose, ineffective adhesions in the "omental" series.

Attention is called to the tendency to the production of acute obstruction during the first two post-operative days because of the swelling, œdema of the jejunal wall at site of the catheter, and local spasm. It is necessary that as small as practicable a catheter should be chosen.³ As a more effectual provision against tissue damage and obstructive symptoms, it is suggested that a Levine tube be placed within the stomach and fluid frequently aspirated

TABLE V

Experimental Table Showing Results with Muscle-peritoneal Graft

| Experiment Number | Duration in Das. | Technic | Findings |
|-------------------|------------------|---|--|
| J. 22 | 9 | S-K | Jejunum natural |
| J. 23 | 3 | S-K | Adhesions incomplete; peritonitis |
| J. 24 | 6 | { S-K Omentum | Adhesions firm; necrosis about tube. (Cf. drawing.) |
| J. 25 | 10 | W (Tube removed) | Adhesions firm; stoma natural; graft viable |
| J. 26 | 2 | { W (c. Interrupted sutures) Omentum | Adhesions firm; invaginated wall congested |
| J. 27 | 2 | { W Omentum | Adhesions firm; invaginated wall congested. (v. Drawing and Microphotograph.) |
| J. 45 | 3 | S-K | Adhesions incomplete at upper angle not covered by graft where "seepage" occurred. Flap viable |

during the first forty-eight hours from the time of reaction from operation, and that such fluid be refrigerated until jejunal feeding. It may then be brought to the proper temperature, mixed with each feeding, and passed into the jejunum. The elaborate preparations of jejunal feedings, as advocated by Ivy, are believed unnecessary if the simple precautions of "naturalizing" the jejunal ingesta outlined above be carried out. The findings after jejunostomies combined with gastroenterostomies emphasize the increased toleration of the jejunum to predigested nutriment when mixed with secretions from the upper reaches of the digestive tract.

If the Witzel technic is employed, as indicated in the accompanying illustrations, some precautions must be taken to safeguard the integrity of the invaginated jejunal wall. The portion invaginated is, of course, antimesenteric and supplied by terminal vessels. Continuous Lembert suturing ligates these end-vessels. Interrupted sutures are not sufficient to prevent deep congestion due to the bending in of this one to two inches of wall. After this

JEJUNOSTOMY

operation, it is recommended that the jejunostomy tube be removed daily, cleaned, and replaced at once. If the tip of the catheter be promptly placed at the entrance of the fistula its re-introduction may be less difficult. This

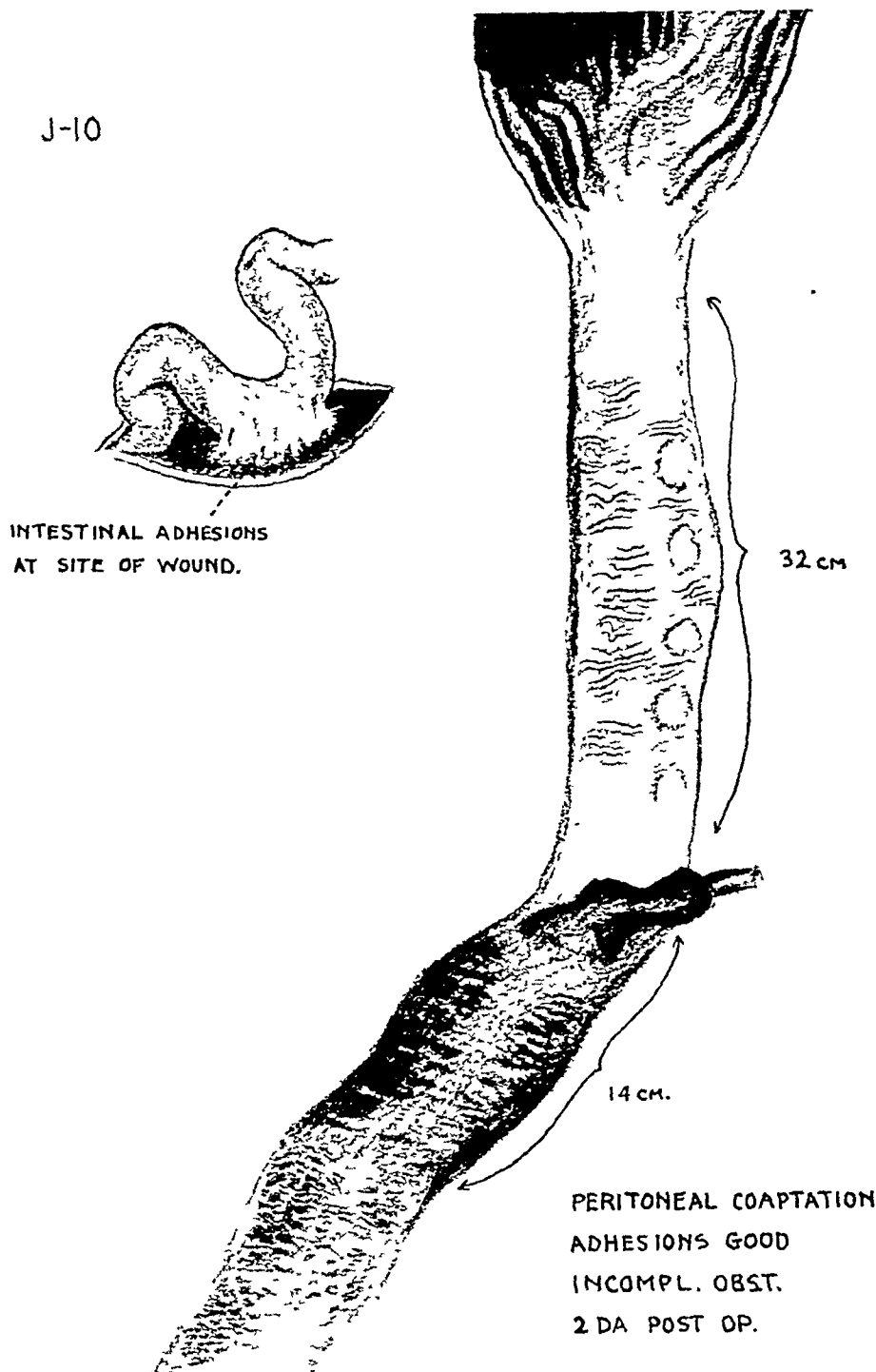


FIG. 11.—J-10. (See Table IV.) Drawing showing ample adhesions (insert) and hæmorrhagic invaginated jejunal wall. Obstruction and necrosis followed.

will allow some time for readjustment of the local circulation within the invaginated wall, the preservation of which protects both peritoneum and skin from leaking intestinal contents.

The utilization of a modified Stamm-Kader technic would seem to sim-

plify the immediate after-care of the fistulous tract and diminish the dangers from necrosis of the invaginated intestinal wall.

It is believed that two factors to be desired in a good jejunostomy are keeping the stomatized loop close to the abdominal wall and keeping the omenta "within call" of the jejunostomy site. It is thought that one virtue

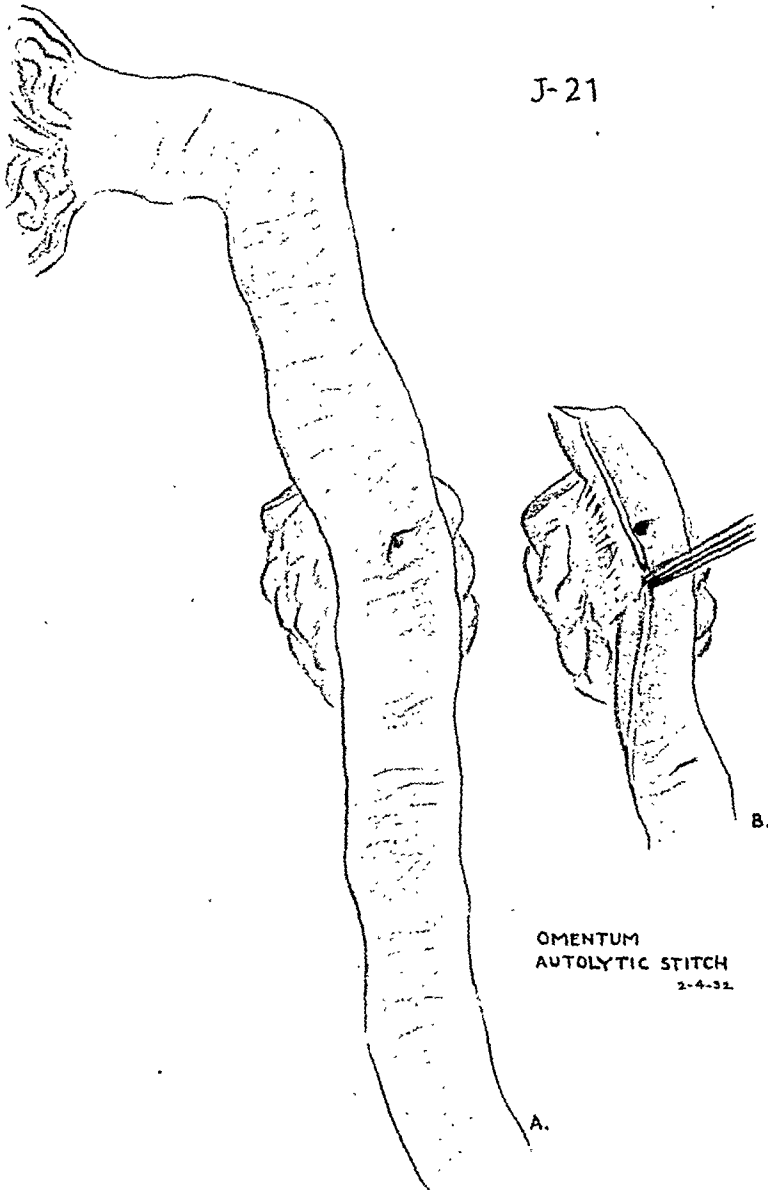
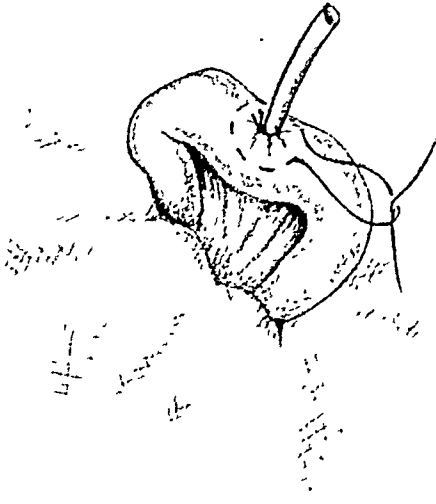


FIG. 12.—J-21. (See Table IV.) Normal viscera and peritoneum following jejunostomy by autolytic stitch and direct peritoneal fixation.

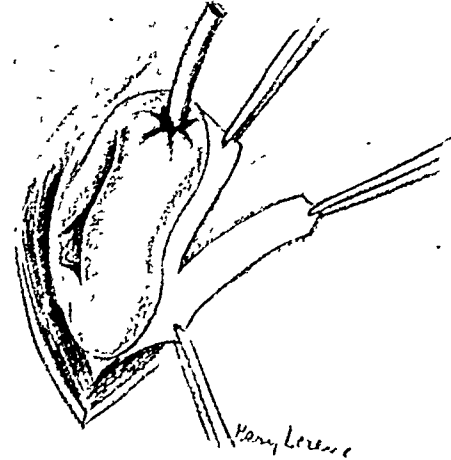
from a *suspended* rather than a *fixed* jejunum and from closely applied omentum is spontaneous closing of the stoma (as is desired in acute cases). This has been observed in the author's few clinical cases. The modification to be suggested, whether new or old, has evolved itself from this series of observations and seems best to meet the indications thus far.

JEJUNOSTOMY

J-24. STAMM-KADER



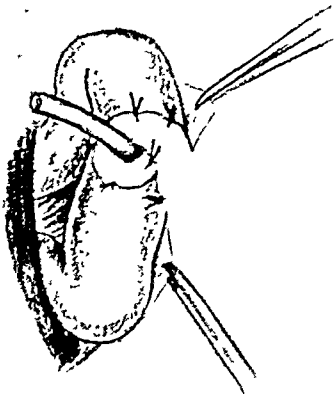
A.



B.

FIG. 13.

J-24.



C.



D.

FIG. 14.

FIGS. 13 AND 14.—(See Table V.) Jejunostomy with author's suggestion of muscle-peritoneal flap taken from edge of operative wound to provide suspension of jejunal loop and peritoneal coaptation. Tube is inverted—not invaginated as in J-26 and J-27.

This procedure, as appears in the accompanying drawings, comprises an attached muscle-peritoneal flap slit off from the lateral edge of the abdominal wound and of sufficient size and shape to adequately cover the line of suture in the Witzel or the circumference of the tube in the Stamm-Kader method.

J-22

FLAP
OMENTUM
S.-K.

2-3-32

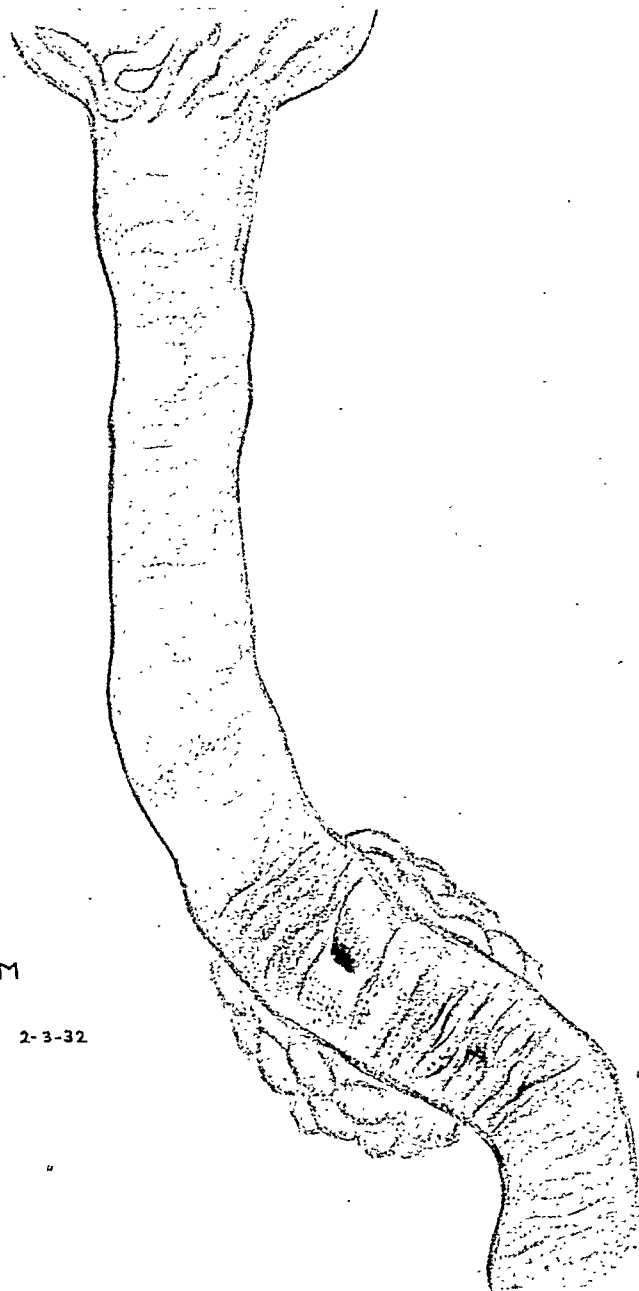


FIG. 15.—J-22. (See Table V.) Specimen showing normal findings following above technic.

This flap is sutured with interrupted Lembert sutures to the jejunal wall. Over this transplant is laid the edge of the great omentum. The wound is thereafter closed in layers with interrupted sutures about the tube. The loop remains suspended by the wound flap. The flap is nourished through its

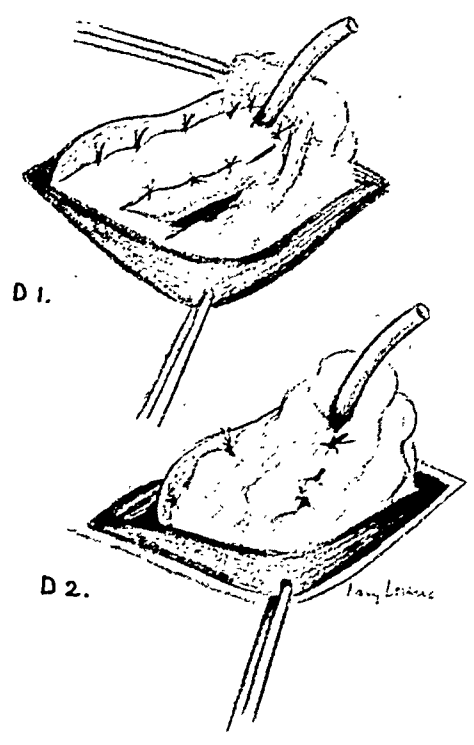
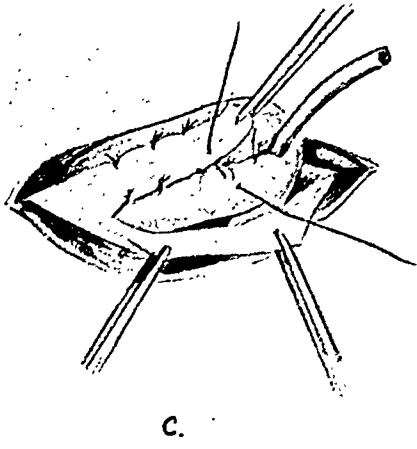


FIG. 16.—J-26. (See Table V.) "W"-jejunostomy with author's suggestion of muscle-peritoneal flap taken from edge of operative wound to provide peritoneal coaptation and suspension (rather than fixation) of jejunum.

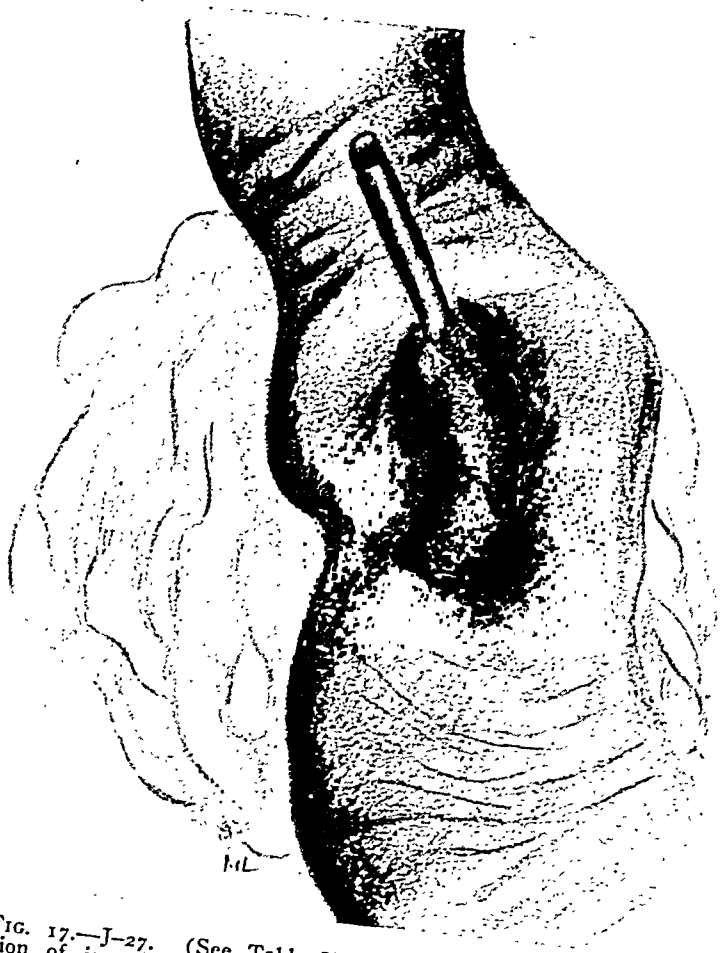


FIG. 17.—J-27. (See Table V.) Same principle as above in J-26 showing objection of invagination of wall still remains. Invaginated wall about tube is deeply congested and may necrose.



FIG. 18.

FIG. 18.—J-27. (See Table V.) Microphotograph to show the hemorrhagic and edematous wall of the invaginated portion of the jejunum.

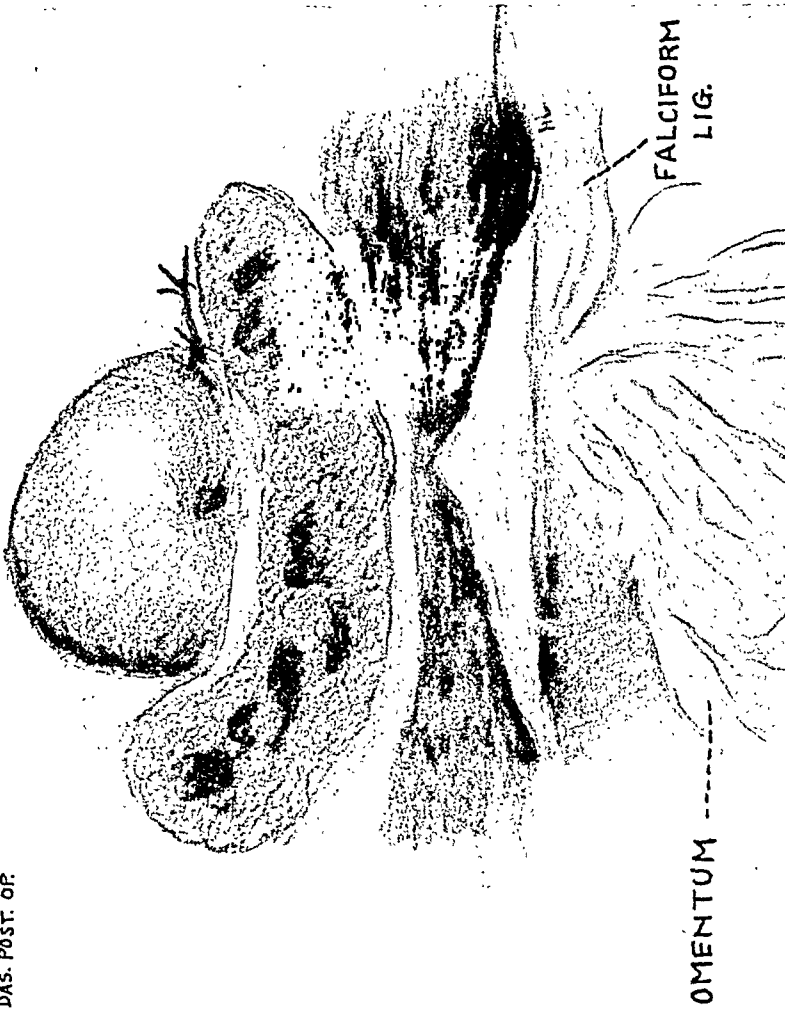


FIG. 19.

FIG. 19.—J-41. (No. 1.) Drawing of experimental jejunojejunostomy in which the loop is left incarcerated within the abdominal wound. Although this principle is safe practice in concolic surgery, it appears hazardous in those cases in which the jejunum is used. Note acutely inflamed jejunal loop and sharply demarcated necrotic space containing characteristic red fluid (as in pancreatic digestion). It is considered safest to divide loop and leave ends at angles of wound as in Case J. M.

JEJUNOSTOMY

attached base and through the new vascular connections from the underlying serosa and overlying omentum. The intraperitoneal adhesions protect the body cavity from peritonitis and the omentum, besides protecting the stomatized loop from harmful adhesions, facilitates spontaneous closure of the ostomy. All considered, this technic varies so little from the one in

J 41

4-4-32.

7DAS PO OP.

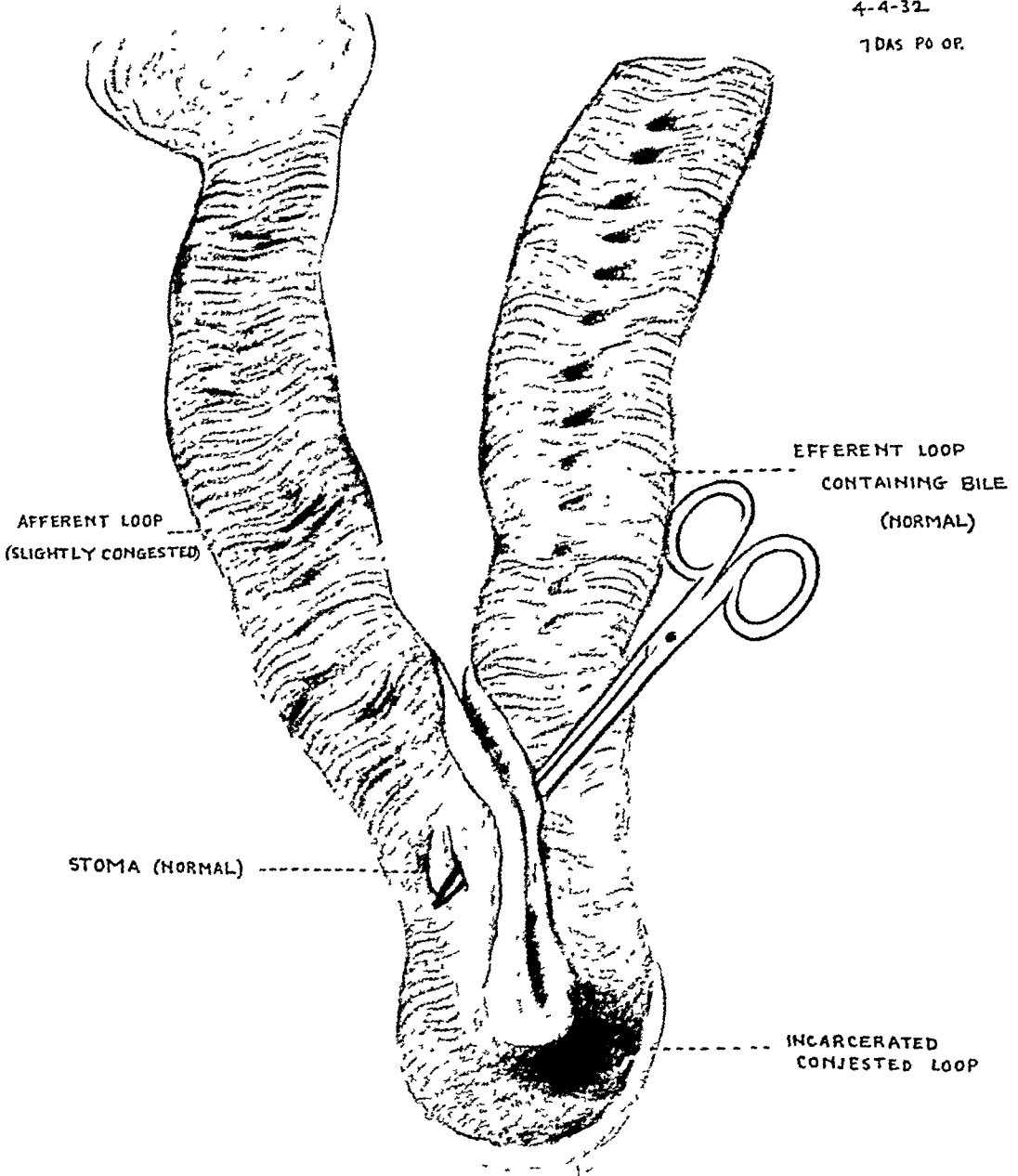


FIG. 20—J-41. (No. 2.) Peritoneum clean. Obstruction from incarcerated loop. Great omentum + falc. lig. strongly adherent about anast. necrotic space, containing red fluid within wall of abdomen.

common usage, requires so little additional time to accomplish, and seemingly has so much more to recommend it, that the author does not hesitate at this time to suggest it.

CONCLUSIONS.—(1) Intestinal obstruction and peritonitis are considered essential causes of failure in a fair proportion of sudden deaths not attribut-

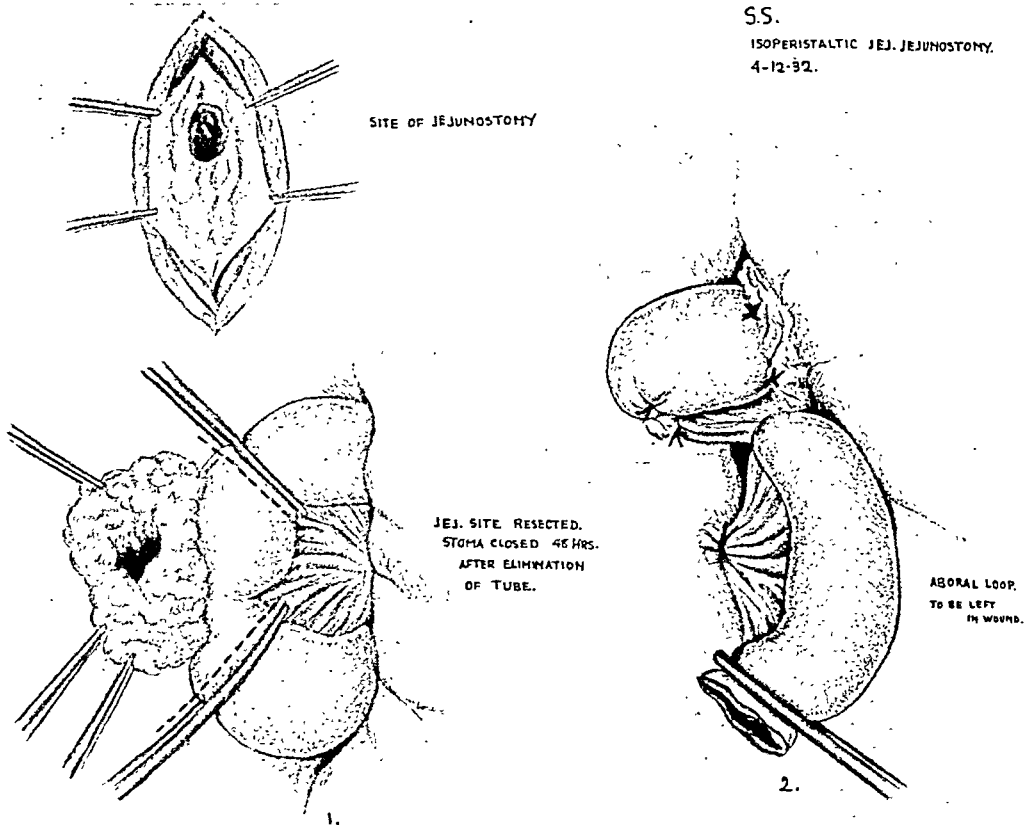


FIG. 21.—S. S. Drawing representing a secondary operation upon a carcinoma case. This case (S. S., Table I) had had a Stamm-Kader operation with graft and was satisfactory excepting for the difficulty in restraining tube from coming out. As in many similar cases it was necessary to reestablish jejunostomy in the operating room. Note resection of old ostomy site with graft (1), closure of oral end and preparation of aboral end for jejunostomy (2). The jejunal stoma had entirely closed forty-eight hours after passing tube and jejunal loops were normal.

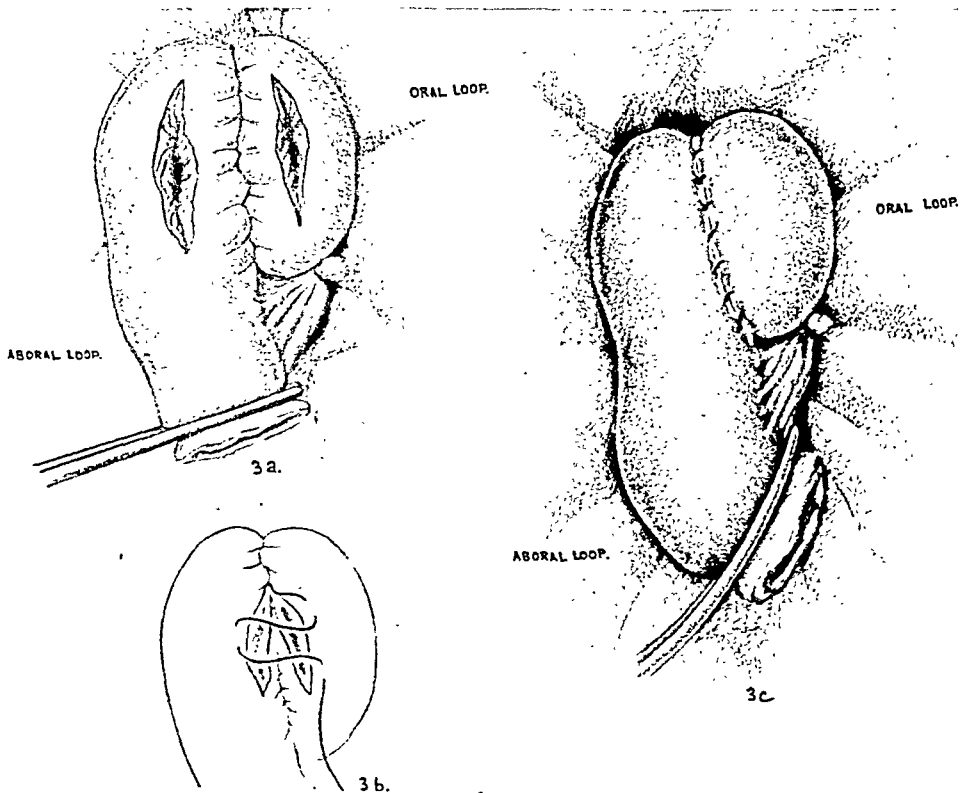


FIG. 22.—S. S. Lateral jejunojejunostomy, isoperistaltic. (Figs. 3a, b, c.)

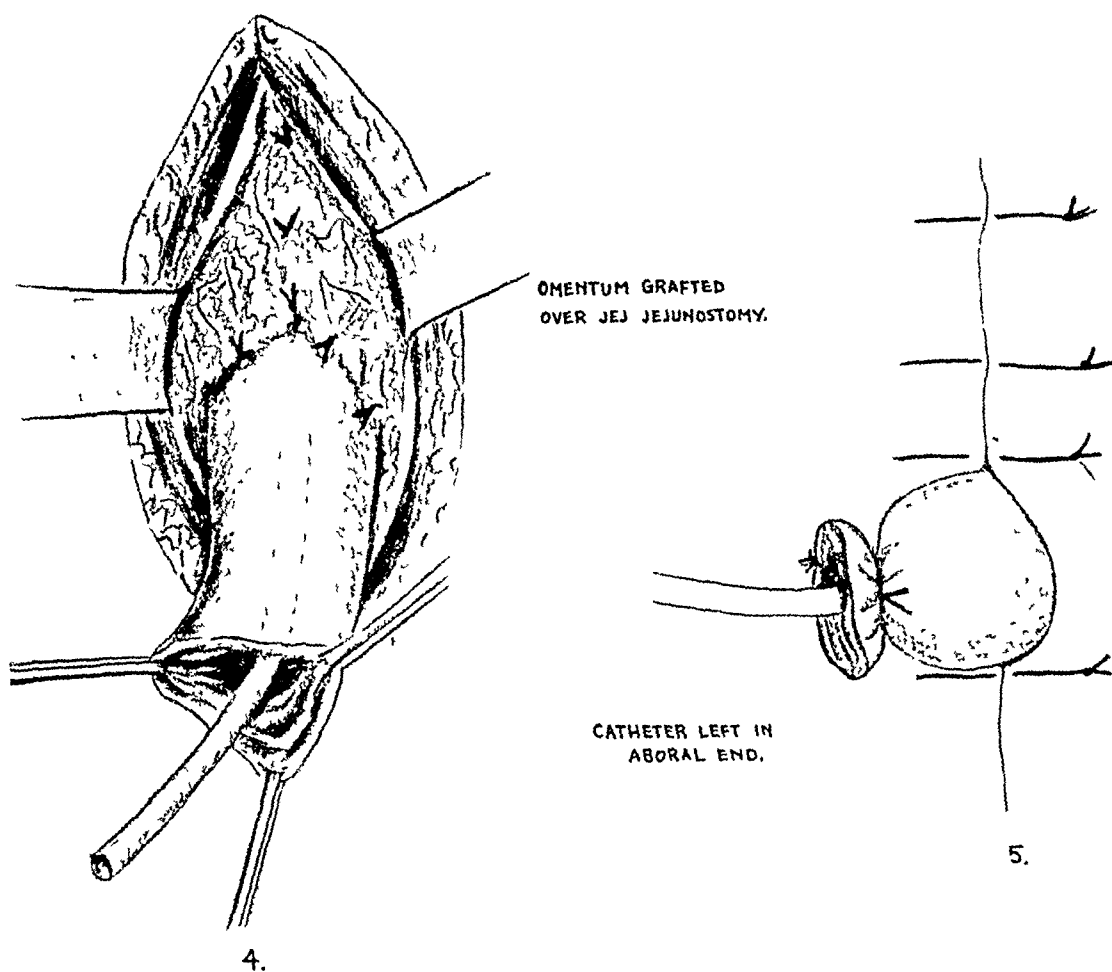


FIG. 23—S. S. (Figs. 4 and 5) Aboral jejunal end left to serve as a jejunostomy while the oral end remains within the abdomen directed caudad and away from the peritoneum.

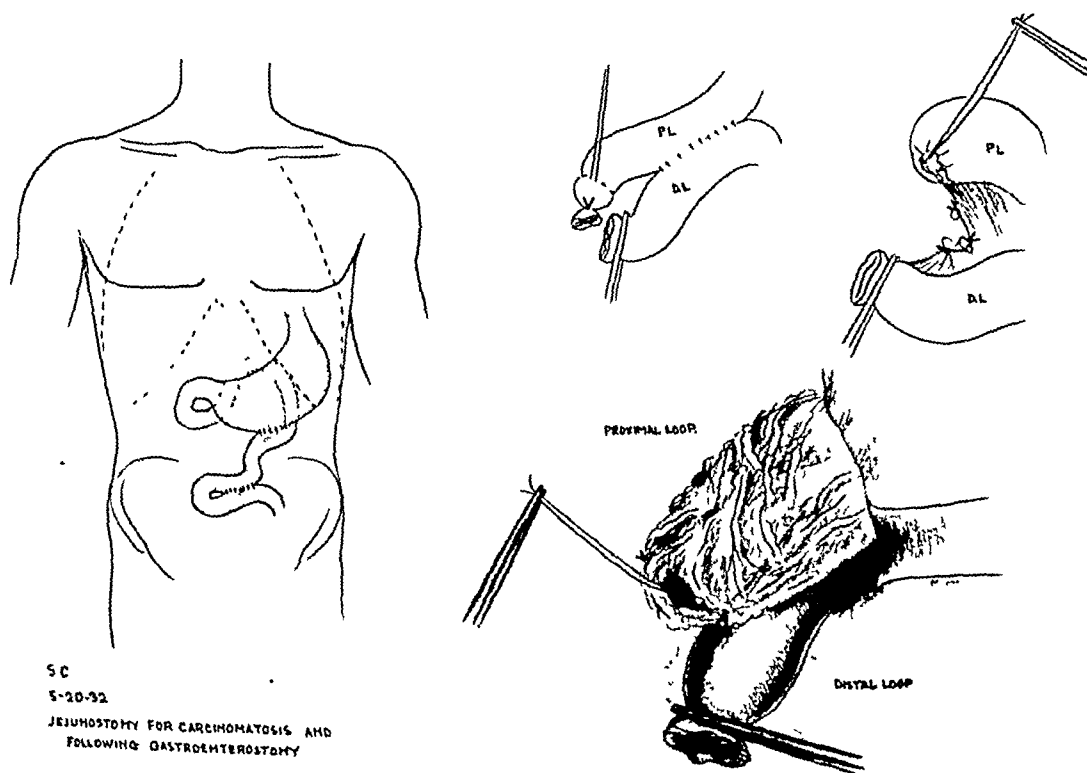


FIG. 24—S. C Drawing to illustrate an advanced carcinoma case upon whom a posterior gastrojejunostomy had been performed for malignancy at the pylorus. Extensions of growth into the mediastinum necessitated further relief. Jejunoejejunostomy, lateral, antiperistaltic, with one end of jejunum in the peritoneal plane and the other reserved for jejunostomy, was attempted. Note omentum about anastomosis.

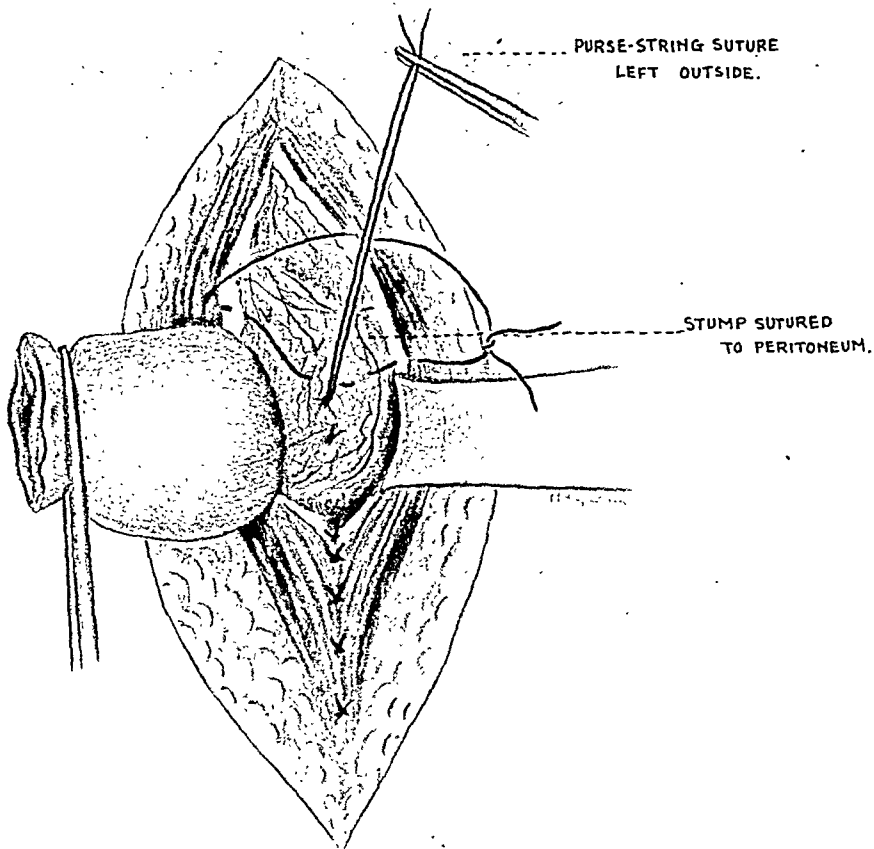


FIG. 25.—S. C. (Fig. 2.) Note ends of purse-string suture left out upon skin to facilitate reopening of stump if inflammation or obstruction occur.

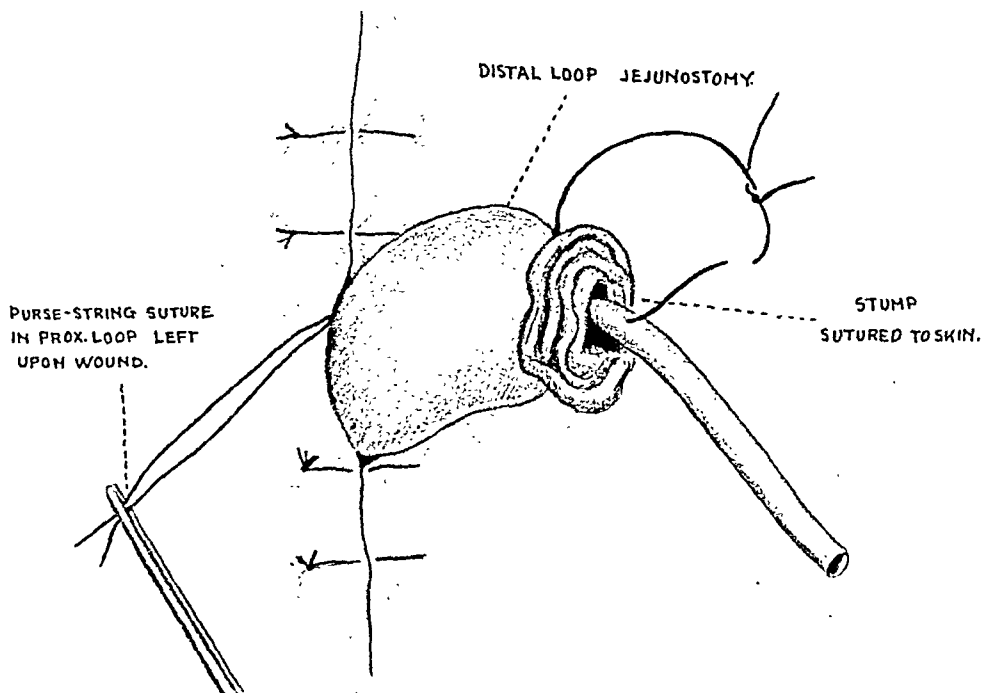
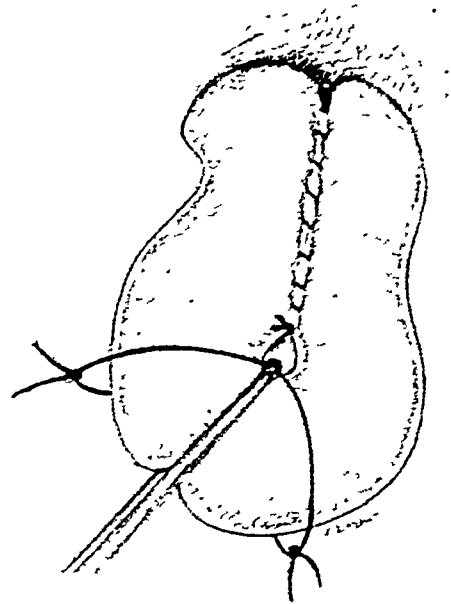
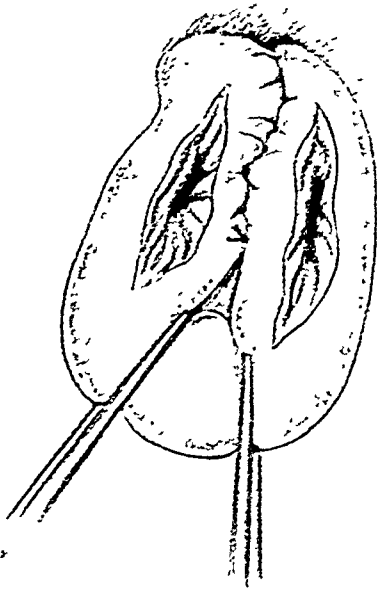
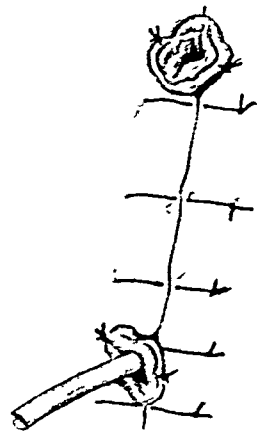
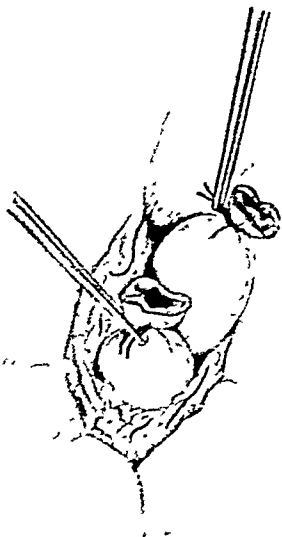


FIG. 26.—S. C. (Fig. 3.) Aboral end temporarily ligated about a catheter and to skin away from wound to protect wound from contamination. Catheter is left out between feedings.

JEJUNOSTOMY



1.
2.
FIG 27.—J. J. M. (Figs. 1 and 2.) Drawing illustrating lateral jejunojejunostomy with the loop drawn out as in the Mikulicz operation.



3.

4.

5.

FIG. 28.—J. J. M. Figs. 3, 4, and 5 represent disposition of divided ends after lateral jejunojejunostomy. The ends are temporarily ligated and sutured to skin to prevent "spillage" of contents into wound. The aboral end is ligated about a catheter to facilitate early feeding but the catheter is left out between feedings after the first forty-eight hours.

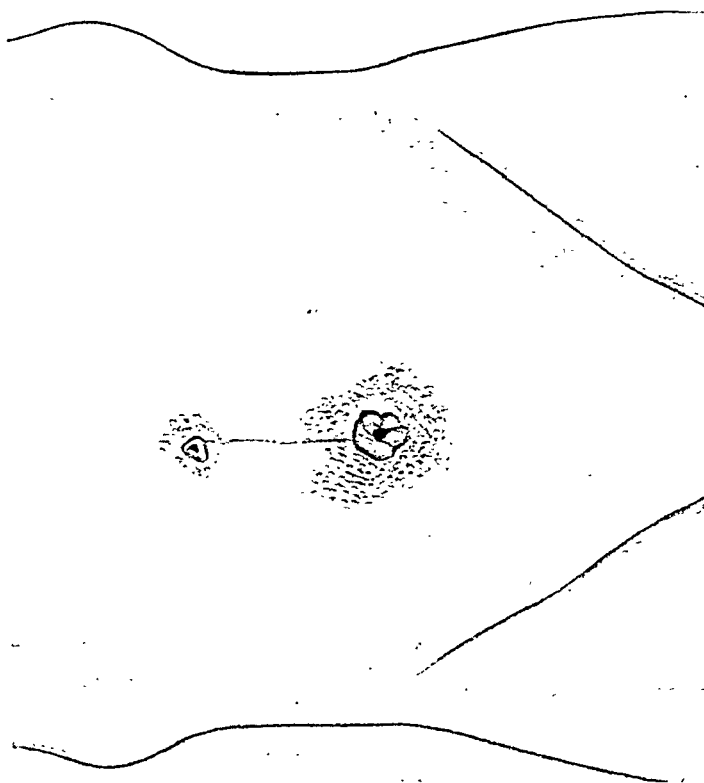


FIG. 29.

FIG. 29.—J. J. M. (Fig. 6.) Note degree of irritation of skin about jejunal stomata after forty-three days of jejunal feeding.

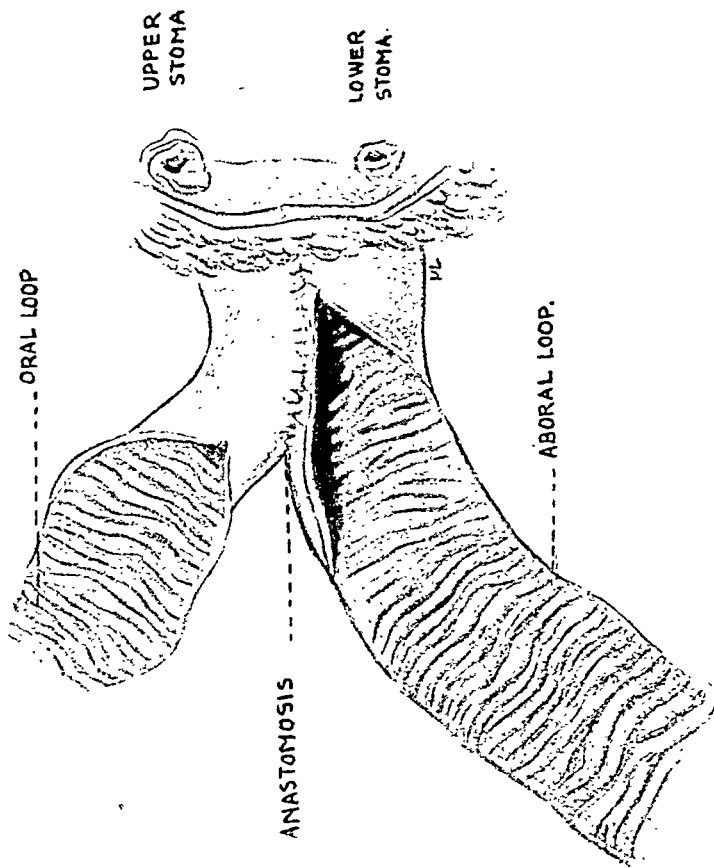


FIG. 30.

FIG. 30.—J. J. M. (Fig. 7.) Drawing to indicate the small degree of jejunal mucosal irritation following frequent daily jejunal feedings. The presence of the two open ends made it possible to divide the feedings between them.

JEJUNOSTOMY

able to systemic disease or new growth occurring within the first few days after jejunostomy.

(2) Symptoms and findings similar to those in acute high intestinal obstruction observed after jejunostomy are relieved by administering gastroduodenal secretions with the jejunal feedings.

(3) The present method of Witzel jejunostomy with peritoneal fixation appears safer than a similar one with interposed omentum.

(4) The Stamm-Kader or inversion technic appears to present less dangers from obstruction, necrosis, and perforation than the Witzel or invagination method.

(5) A method is recommended of utilizing a muscle-peritoneal graft which seals in the suture line, suspends the jejunal loop, provides for omental protection, and which is believed to favor spontaneous closure of the ostomy.

(6) It is suggested that jejunostomy with an indwelling catheter be reserved for those emergency cases in which jejunostomy is required for a few days only and that during this interval gastroduodenal secretions be collected and administered with the jejunal feedings.

One of the greatest concerns in the after-care of the jejunostomy patient is the catheter. There is fear of the tube coming out and fear of difficulty in replacing the tube. It has frequently been necessary to take these sick patients to the operating-room to re-introduce the tube, a procedure although minor, operatively, has repeatedly proved fatal to the patient. It is therefore recommended that the catheter technic described above be reserved for the acute emergencies, especially the occasional inflammatory case requiring jejunostomy but for a few days and that jejunostomy without the tube be carried out in those individuals having an expectancy of weeks to months.

Obviously jejunojejunostomy may be performed expeditiously and with little peritoneal traumata. By this procedure a continuity of the duodeno-jejunal tract is assured. Many variations in the methods of anastomosis have been advocated but the simplest and safest method seems to be the anastomosis of the adjacent walls of a jejunal loop pulled out as in the Mikulicz operation and protected by omentum. This technic appears below.

What to do with the jejunal loop has been the subject of experimentation and clinical observation. Experimentally, it is obvious that the jejunal loop cannot be treated as can a loop of colon. The loop has been left within the wound attached to the skin or has been brought out upon the skin. Such incarcerated loops may become deeply congested, allow the passage of digestive secretions through their walls, and cause necrosis within the wound. (See accompanying drawing, J.41, Numbers 1 and 2.) The jejunal loop may be divided and one or both ends left on the surface of the skin to one side or other of the wound as illustrated in the following clinical cases. (See drawings S.S., 1-5, S.C., 1-3, and J.J.M., 1-7.) Of these methods of disposing of the divided ends of the jejunum the third with both ends upon the skin has given the best results. It provides two stomata for feeding which is

fortunate when one becomes spastic from too much irritation. (J.J.M., Fig. 6.) It is believed that distension of the upper abdomen remains less. Furthermore, there is no possibility of contamination of the peritoneum or wound with secretions or with infectious material from the lumen of the bowel.

The improvement in the jejunitis observed in the few clinical cases in the Bellevue series is striking. The wearing of the catheter for a long period after jejunostomy must constitute a very important factor in such inflammation. This condition may be further relieved by extreme gentleness and cleanliness in the technic of feeding and by regularly introducing in small amounts at first properly heated peptonized food together with mucus, vitamins, and such enzymes and medications as may appear indicated. An attempt has been made to work up to a balanced diet and, in appropriate cases, to supply enough proteins to utilize the pancreatic secretion. Heyd⁴ recommends a diet in the proportion of 100 grams of protein, 185 of fat, and 500 of carbohydrate. Whipple⁵ feels there are advantages in sterilizing the fluid used in feeding jejunostomy cases. Liver, cod-liver oil, and ferric ammonium citrate, as advised by Wyckoff and Connery,⁶ have been administered to relieve the secondary anæmias. It has been gratifying to note the increased comfort of these unfortunate patients and a revelation to find natural jejuna in the few cases observed after two or more months of this simple care. There is an occasional gain in weight and the patient may be up and about, either assisting in or attending to his feedings himself.

In conclusion, it is recommended that a permanent method of jejunostomy by which is meant jejunojejunostomy combined with the leaving of the divided ends outside of the wound and the entire doing away with the wearing of a catheter be utilized in inoperable cases requiring jejunostomy over protracted periods.

NOTE.—The author gratefully acknowledges the coöperation of Dr. G. D. Stewart, Dr. A. M. Wright, and his associates on the Third Division at Bellevue Hospital; Dr. I. Graef for assistance with the pathological material; Dr. Co-Tui, Dr. S. Nussbaum, Miss M. Lorenc, and the Experimental Staff at the University and Bellevue Hospital Medical College for valuable assistance in the experimental surgery and drawings.

BIBLIOGRAPHY

- ¹ Especially cases dying within forty-eight hours.
- ² Similar considerations would seem to apply to the care of the duodenal stump after gastric resection.
- ³ Nussbaum informs me that the catheter used in the human cases (18 F.) is proportionately greater in circumference than that used in the experimental series.
- ⁴ Heyd, C. G.: *Am. Jour. Surg.*, vol. i, No. 4, pp. 188-191.
- ⁵ Whipple, A.: Personal communication.
- ⁶ Wyckoff, J., and Connery, J. E.: Personal communication.

AVERTIN ANÆSTHESIA

A STUDY OF 431 CASES COMPARED WITH 431 SIMILAR CASES OPERATED ON
UNDER OTHER TYPES OF ANÆSTHESIA, AT THE BROOKLYN HOSPITAL

BY WILLIAM H. FIELD, M.D., AND LEWIS S. PILCHER, 2ND, M.D.
OF BROOKLYN, N.Y.

AVERTIN anæsthesia was first used at the Brooklyn Hospital in October, 1930. During the next eighteen months it was used chiefly as a basal anæsthetic with increasing frequency. The majority of the staff, however, were never completely satisfied with the results attained. Only a few used avertin routinely for their ordinary surgical work. The level of anæsthesia produced often seemed very variable. In many instances peculiar, sometimes very disturbing post-operative reactions occurred. Finally in one week three patients who had had avertin died within forty-eight hours after operation, under rather peculiar circumstances, which it was feared might have some relation to the anæsthetic used. There was a growing feeling that avertin might not, after all, be the ideal, safe anæsthetic that it was supposed to be. Because of this feeling it was decided to make a careful statistical study of all the cases in which avertin had been used in the Brooklyn Hospital, and to compare this with a similar study of a control group of cases in the same hospital in which the ordinary routine anæsthetics—chiefly ether, gas-oxygen, or novocaine—were used. The control group was collected by listing in detail the types of operations done under avertin and selecting from the recent files of the hospital cases in which as nearly as possible exactly similar operations were done under other anæsthetics. A condensed, comparative list of the operations in the two groups of cases studied is given in Table I. The results of the comparative statistical studies of these two groups of cases form the basis of this report.

During the eighteen-month period included in this study avertin was used in 431 operations, or, roughly, 19 per cent. of all the operations performed at the hospital during this time, exclusive of operations in the Ear, Nose and Throat service. The type of operation in which avertin was used varied from complicated major operations to such minor procedures as excision of ingrown toe-nails, or circumcisions. About three-quarters of the operations were major operations. The group included patients of all ages from five to eighty-three years.

Properties of "Avertin Fluid."—The preparation of avertin which was used was "Avertin Fluid." (Winthrop.) This is a solution of tri-brom-ethyl-alcohol (avertin) and amylene hydrate in the proportion of 1 gram of avertin and $\frac{1}{2}$ cubic centimetre of amylene hydrate to 1 cubic centimetre of solution. The avertin is the most potent part of the solution. The amylene hydrate is said to increase the solubility and rapidity of absorption of the

TABLE I
Comparative List of Operations

| Operations | Avertin Group | Control Group |
|--|---------------|---------------|
| Cystotomy..... | 9 | 9 |
| Prostatectomy..... | 7 | 7 |
| Thyroidectomy (carcinoma)..... | 1 | 1 |
| Sub-total Thyroidectomy (adenoma)..... | 6 | 6 |
| Sub-total Thyroidectomy (Graves)..... | 21 | 21 |
| Lobectomy, Thyroid (adenoma)..... | 6 | 6 |
| Thyroidectomy, two-stage (Graves)..... | 2 | 2 |
| Cholecystectomy..... | 9 | 9 |
| Cholecystectomy and Gastroenterostomy..... | 2 | 2 |
| Cholecystotomy..... | 2 | 2 |
| Posterior Gastroenterostomy..... | 4 | 4 |
| Gastrotomy..... | 1 | 1 |
| Nephrectomy..... | 6 | 7 |
| Hemi-nephrectomy..... | 1 | |
| Pyelotomy..... | 11 | 11 |
| Pyelotomy and Nephrotomy..... | 1 | 1 |
| Ureterotomy..... | 5 | 5 |
| Radical Mastectomy..... | 5 | 5 |
| Simple Mastectomy..... | 7 | 7 |
| Excision Breast Tumor..... | 6 | 6 |
| Excision carcinoma axilla..... | 2 | 2 |
| Dilatation and curettage..... | 15 | 15 |
| Cæsarean section..... | 13 | 13 |
| Vaginal repair and insertion of Radium..... | 14 | 14 |
| Vaginal repair..... | 33 | 33 |
| Vaginal repair and Laparotomy..... | 11 | 11 |
| Suspension of uterus..... | 6 | 6 |
| Excision ovarian cyst..... | 8 | 8 |
| Salpingectomy..... | 4 | 4 |
| Salpingectomy and Appendicectomy..... | 3 | 3 |
| Supra-vaginal Hysterectomy..... | 48 | 48 |
| Hysterotomy..... | 5 | 5 |
| Thoracotomy with rib resection..... | 14 | 14 |
| Laminectomy..... | 3 | 3 |
| Inguinal hernia repair..... | 22 | 22 |
| Repair of inguinal hernia and hydrocele..... | 4 | 4 |
| Repair of strangulated inguinal hernia..... | 2 | 2 |
| Repair of femoral hernia..... | 2 | 2 |
| Repair of ventral hernia..... | 1 | 1 |
| Repair of strangulated ventral hernia..... | 1 | 1 |
| Appendicectomy..... | 22 | 22 |
| Appendicectomy with drainage..... | 7 | 7 |
| Mid-thigh amputation..... | 3 | 3 |
| Other operations (fifty-four different types)..... | 74 | 74 |

avertin, but it must also exert a moderate hypnotic effect of its own, since the usual dosage of the solution contains 2 to 4 cubic centimetres of amylene of which the United States Pharmacopœia hypnotic dose is 3 to 5 cubic centimetres. The action of amylene is similar to that of paraldehyde but

two to three times as strong. "Avertin Fluid" is said to be rapidly absorbed from the rectum, about 80 per cent. in the first twenty minutes and 95 per cent. in the first two hours. During anæsthesia, concentration of avertin in the blood has been found to be around 6 to 9 milligrams per 100 cubic centimetres. Figures for the concentration of amylene hydrate have apparently not been published. After absorption through the blood the avertin is supposed to be rapidly detoxified by the liver; in Eicholtz's experiments this occurred at a rate faster than ether was exhaled. After detoxification, Parsons, Straub, and others have found that at least 98 per cent. is excreted by the kidneys, in combination with glycuronic acid, 70 to 80 per cent. within forty-eight hours, 90 to 95 per cent. within seven days.^{1, 2, 3, 4, 5, 6, 7}

Method of Administration.—The system that was followed in administering the avertin anæsthesia was briefly as follows. An enema was given twelve hours before operation. On the supposition that supplementary anæsthesia might be needed the usual pre-ether orders of fluids until eight hours before operation, then nothing by mouth, were usually followed. In almost all cases except thyrotoxic patients (who were usually kept unaware of the impending operation), a pre-operative hypodermic of morphine and atropine was given shortly before the avertin—ideally twenty minutes before. In thyrotoxic patients a hypodermic of atropine alone was given shortly after the avertin. In the group of 431 cases 348 received morphine pre-operatively, usually with atropine, and forty-five received atropine alone. Others had pantopon, codeine, opium, or luminal. Only twenty-five had no pre-operative medication. Avertin with morphine seemed to produce a smoother basal anæsthesia than avertin alone, without excessive respiratory depression. The combination of pantopon with avertin, as used in six cases, seemed to depress respirations to an undesirable degree.

The avertin solution for each case was freshly prepared in the operating room from a concentrated stock solution, under the supervision of the anæsthesia department, with special attention to the proper temperature and to testing with Congo red for possible acid decomposition. The mixed solution was then quickly taken to the ward and injected slowly through a rectal catheter, the solution being re-tested for temperature and acid if there was any delay in preparing the patient.

After the avertin was given it was believed best to wait twenty minutes before attempting to start the operation. However, only 18 per cent. of the operations were actually started at the theoretically ideal time although over 98 per cent. of the patients were asleep within the twenty-minute interval. Two per cent. were started sooner than twenty minutes after, 47 per cent. between thirty and forty minutes after, 25 per cent. between forty and fifty minutes after, and 8 per cent. later than fifty minutes after the avertin was given.

This brings out one of the difficulties attached to the use of a fixed anæsthetic like avertin in a busy operating schedule. If the anæsthetist waits to mix and give the avertin (which must be prepared freshly in each case),

until after the operator has finished the preceding operation, the operator must wait thirty minutes or more before the patient is ready. If, on the other hand, the anæsthetist gives the avertin before the preceding operation is finished completely—which was necessary in a majority of the operations in this group—the operator may be delayed or interrupted, postponing the start of the operation beyond the ideal twenty-minute interval following the injection of the avertin. This delay is not of such importance, however, if avertin is used for basal anæsthesia only, as it was in most of these cases.

Dosage.—The dosage of avertin which was used varied considerably with the individual patient or operator, ranging from 60 to 100 milligrams per kilo. Two hundred eighty-three received the top dose of 100 milligrams; 120, 80 milligrams; thirteen, 90 milligrams; eleven, 60 milligrams; and two, 70 milligrams. In general, the lowest doses (60 to 70 milligrams) usually produced sleep without anæsthesia; the 80- to 90-milligram doses, deep sleep with a moderate degree of surgical anæsthesia in some cases; and the 100-milligram dose deep sleep with complete surgical anæsthesia in a few cases only, but with moderate anæsthesia in most of the cases. The size of the dosage also had a considerable effect on the rapidity of induction. With a 100-milligram dose, 81 per cent. of the patients were asleep within ten minutes and all but two of the remainder within twenty minutes, while with 80 milligrams only 54 per cent. were asleep within ten minutes and all but three of the rest asleep within twenty minutes. The duration of sleep showed a similar but less marked relation to the dosage. (Table III.) As mentioned above, however, the level of anæsthesia even with the same dose per kilo varied greatly with different patients.

Supplementary Anæsthesia.—Supplementary anæsthesia was needed in all but fifty-two of the 431 cases, since avertin was used chiefly as a basal anæsthetic to initiate and maintain unconsciousness without producing complete pain anæsthesia or muscular relaxation. Gas-oxygen was added in 205, gas-oxygen and ether sequence in 152, and novocaine local infiltration in 22. More supplementary anæsthesia was needed with the smaller than with the larger doses of avertin. The figures for the 431 cases show that with a 100-milligram dose, 16 per cent. required no supplementary anæsthesia, 49 per cent. were carried on gas-oxygen, and only 30 per cent. required ether, while with the 80-milligram dose only 7 per cent. required no supplementary anæsthesia, 41 per cent. were carried on gas-oxygen, and 47 per cent. required ether. In the remaining cases the avertin was supplemented by local anæsthesia.

On theoretical grounds it would seem that the ideal supplementary anæsthetic for avertin should be novocaine local infiltration. In many of the cases included in this study, however, it was found that although avertin when combined with local anæsthesia produced insensibility to pain and often amnesia, voluntary movements, and in many cases speech, were not always abolished and the patient would occasionally move or talk at an extremely inconvenient moment. In such instances the patient would not respond to

AVERTIN ANÆSTHESIA

orders or requests as he would under ordinary local or spinal anæsthesia. A few experiences with patients who insisted on talking while the operator was attempting to reduce a hernia or who tried to put their hands in the wound showed that avertin and local anæsthesia were not always as ideal a combination as might be thought.

In order to determine what type of supplementary anæsthesia was usually needed to obtain satisfactory anæsthesia for different types of operation, a special study was made of the kind of anæsthesia used for the more common operations with and without avertin. The results of this study are shown in Table II. The figures in this table show that with avertin a great number of major operations were done without the use of ether, which previously required full ether anæsthesia. Over 50 per cent. of the major operations in this group were done satisfactorily under the combination of gas-oxygen and avertin. In the control group, less than 6 per cent. of the major operations could be done under gas-oxygen without ether. On the other hand, there were a few operations such as cystotomies and rib-resections which were previously done chiefly under local anæsthesia with no inhalation anæsthesia, which required supplementary inhalation anæsthesia when avertin was used. All of the cystotomies and all but five of the fourteen rib-resections in the control group were done with local anæsthesia. When avertin was used instead of local it was found necessary to resort to supplementary

TABLE II

Type of Supplementary Anæsthesia Used for Different Types of Operations

| Operation | Avertin Group | | | | Control Group | | | |
|-----------------------------|---------------|------|-------|------|---------------|------|-------|-------|
| | Ether | G.O. | Local | None | Ether | G.O. | Local | Other |
| Cystotomy (9)..... | 5 | 2 | 0 | 2 | 0 | 0 | 9 | 0 |
| Prostatectomy (7)..... | 3 | 3 | 0 | 1 | 4 | 0 | 3 | 0 |
| Thyroidectomy (38)..... | 7 | 29 | 0 | 2 | 26 | 12 | 0 | 0 |
| Cholecystectomy (11)..... | 7 | 3 | 1 | 0 | 11 | 0 | 0 | 0 |
| Cholecystotomy (2)..... | 0 | 1 | 1 | 0 | 2 | 0 | 0 | 0 |
| Gastroenterostomy (4).... | 2 | 2 | 0 | 0 | 3 | 0 | 0 | 1 |
| Gastrotomy (1)..... | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| Pyelotomy (12)..... | 2 | 9 | 0 | 1 | 12 | 0 | 0 | 0 |
| Nephrectomy (7)..... | 1 | 6 | 0 | 0 | 7 | 0 | 0 | 0 |
| Ureterotomy (5)..... | 0 | 5 | 0 | 0 | 5 | 0 | 0 | 0 |
| Breast operation (20)..... | 3 | 13 | 1 | 3 | 18 | 2 | 0 | 0 |
| D. and C. (15)..... | 1 | 9 | 0 | 5 | 15 | 0 | 0 | 0 |
| Vaginal repair (47)..... | 10 | 27 | 0 | 10 | 46 | 0 | 0 | 1 |
| Vag. and Lap. (11)..... | 7 | 2 | 1 | 1 | 11 | 0 | 0 | 0 |
| Suspension uterus (6).... | 2 | 4 | 0 | 0 | 5 | 0 | 0 | 1 |
| Salpingectomy, etc. (15)... | 9 | 2 | 0 | 4 | 15 | 0 | 0 | 0 |
| Hysterectomy (48)..... | 35 | 10 | 1 | 2 | 46 | 0 | 0 | 2 |
| Hysterotomy (5)..... | 1 | 2 | 0 | 2 | 3 | 0 | 2 | 0 |
| Repair hernia (35)..... | 10 | 14 | 10 | 1 | 23 | 0 | 11 | 1 |
| Rib-resection (14)..... | 1 | 11 | 1 | 1 | 1 | 4 | 9 | 0 |
| Appendicectomy (29)..... | 18 | 10 | 1 | 0 | 27 | 0 | 0 | 2 |
| Totals..... (341) | 125 | 164 | 17 | 35 | 281 | 18 | 34 | 8 |

inhalation anæsthesia in seven of the nine cystotomies and twelve of the fourteen rib-resections.

Post-operative Course after Avertin.—One of the chief advantages argued for avertin has been that the post-operative course is unusually smooth and comfortable for the patient, due chiefly to three factors: (1) The prolonged sedative effect of the bromide-containing avertin, which produces stupor and drowsiness for several hours after operation and amnesia for a considerable part of the same period; (2) absence or diminution of the usual disturbing post-anæsthetic vomiting; (3) decrease of post-operative respiratory complications. In this group of cases the following effects in relation to these three factors were noted.

(1) *Post-operative Sedative Effect.*—With the ordinary forms of anæsthesia, as used in the control group of cases—gas-oxygen or gas-oxygen and ether—the patients usually awoke within a short time after the anæsthesia was stopped, passing through a fairly short excitement stage. When avertin was used as a basal anæsthetic, this awakening stage was much delayed and the short excitement period was replaced by a much longer period of intermittent restlessness of varying degree. The length of unconsciousness following avertin varied somewhat with the dosage but not as much as might be expected. None of the patients were awake within less than one hour. A few slept for six to eight hours or longer. (Table III.) The average duration of deep sleep with the 80 to 100 milligrams per kilo doses was two to five hours, which was followed by a period of drowsiness for four to twelve hours longer, interrupted in many cases by periods of restlessness often requiring morphine or a similar sedative. During this period of drowsiness and restlessness anæsthesia did not persist, so that morphine was often necessary also to control post-operative pain. Of the avertin cases post-operative restlessness was marked enough to be mentioned in 38 per cent. of the cases and was very marked in 14 per cent. Three hundred twenty-eight of the patients or 76 per cent. required post-operative morphine or a similar sedative to control restlessness or pain within the first twelve hours after operation. In the control cases restlessness was mentioned in only 21 per cent. and very marked restlessness in only 8 per cent. Three hundred four or 70 per cent.

TABLE III
Duration of Sleep after Avertin

| Time of Awakening after Avertin Given | 100 Milligrams per Kilo | 80 Milligrams per Kilo |
|--|----------------------------|---------------------------|
| less than 1 hr. | 0 | 0 |
| 1 to 1½ hrs. | .3% | 3 % |
| 1½ to 2 hrs. | 7 % | 15 % |
| 2 to 3 hrs. | 38 % | 41 % |
| 3 to 4 hrs. | 32 % | 25 % |
| 4 to 5 hrs. | 15 % | 12 % |
| 5 to 6 hrs. | 4 % | 2 % |
| 6 to 7 hrs. | 3 % | 1.5% |
| over 7 hrs. | .7% | .5% |

AVERTIN ANÆSTHESIA

required morphine or similar sedative within the first twelve hours after operation.

This longer duration of unconsciousness and irregular as well as increased restlessness after avertin meant that it was necessary to give avertin patients special post-operative care for a much longer period than with other anæsthetics. The patient was undoubtedly much more comfortable—especially since the events of the first few hours after operation were usually entirely forgotten—but the nursing problem of the hospital was greatly increased. The patients appeared just as irresponsible during the prolonged drowsy, restless period of awakening from avertin as during the shorter excitement stage following ether.

(2) *Post-operative Vomiting*.—Post-operative vomiting was mentioned in the nurses notes in 242 or 56 per cent. of the control group of cases. Of these, 39 per cent. had only slight vomiting, and 61 per cent. moderate or marked vomiting. In the avertin group similar mention of vomiting was found in 181, or 42 per cent. of the cases (14 per cent. less than in the control group) and the severity of vomiting was also less, only 46 per cent. instead of 61 per cent. having moderate or marked vomiting. As shown in Table IV this decrease appeared to be due in large part to the decreased use of ether, first by using smaller amounts of ether when ether was needed to supplement the avertin, and secondly by substituting gas-oxygen for ether in a large number of cases (the incidence of vomiting following the gas-oxygen and avertin combination being much less than that after either gas-oxygen or ether alone). Since vomiting following gas-oxygen alone is usually immediately after operation and of short duration, the comparative absence of vomiting after the gas-oxygen-avertin combination may probably be explained as due to suppression of the nausea reflex by the avertin during the immediate post-operative period.

TABLE IV
Incidence of Post-operative Vomiting

| | Avertin Group | Control Group |
|---|------------------|------------------|
| Total number, vomiting..... | 181 | 242 |
| Total per cent, vomiting..... | 42% | 56% |
| Slight vomiting..... | 54% | 39% |
| Marked or moderate vomiting..... | 46% | 61% |
| Of cases having ether, vomiting..... | 55% | 60% |
| Slight vomiting..... | 53% | 34% |
| Marked or moderate vomiting..... | 47% | 66% |
| Of cases having gas-oxygen, vomiting..... | 39% | 67% |
| Of cases having no inhalation anæsthesia, vomiting..... | 20% | 19% |

The incidence of post-operative vomiting also varied somewhat with the type of operation performed. In operations such as appendicectomy, cholecystectomy, hysterectomy and thyroidectomy, where factors other than the anæsthesia presumably play a prominent part in the production of vomit-

ing, the incidence was practically the same in both avertin and control cases. But in other operations as in vaginal, breast, hernia or orthopædic cases, where there would presumably be little except the anæsthetic to cause vomiting, the incidence was much higher in the control cases than in the avertin cases. This difference was especially marked in the orthopædic operations, vomiting occurring in ten cases in the ether group and in only one of the avertin cases.

(3) *Post-operative Respiratory Complications.*—In studying post-operative respiratory complaints a list was made of all cases in which cough or other respiratory symptoms were mentioned in the nurses or doctors notes within three days after operation. These cases were then studied in detail as regards pre-operative cardio-respiratory symptoms, type of anæsthetic used, type of operation performed, and severity and duration of post-operative symptoms.

Post-operative respiratory complications were found to have occurred in a considerably larger number of cases in the avertin group—in eighty-six cases or 20 per cent., as against seventy-one cases or 16 per cent. of the control group. There were, however, a great many more pre-operative cardiac and respiratory complications in the avertin group, since avertin was quite frequently used as a basal anæsthetic in the presence of cardiac or respiratory pathology with the idea of reducing the amount of inhalation anæsthesia, especially ether, used. Excluding all these cases with pre-operative cardiac or respiratory complications, the incidence of post-operative respiratory troubles in the remaining cases was much higher in the control group in the ratio of 30 to 21. The incidence of the more serious post-operative respiratory complications—acute bronchitis and bronchopneumonia—was also much higher in the control group, in a ratio of 16 to 8.

The thirty control cases and the twenty-one avertin cases which had no local cardio-respiratory complications before operation were studied in more detail. Of the thirty control cases twenty-nine (97 per cent.) had had ether anæsthesia, although ether was used in only 82 per cent. of the control group of 431 cases as a whole. Of the twenty-nine cases which had ether, thirteen had serious respiratory complaints—seven pneumonia, and six bronchitis. Of the twenty-one avertin cases eleven had had supplementary ether, seven gas-oxygen and three avertin alone. Two of the eleven ether cases had pneumonia. The others had minor respiratory complaints.

In the cases which had cardiac or respiratory complications before operation there was no difference in the gross incidence of post-operative respiratory complaints when avertin was used. In the avertin and the control group of cases almost exactly the same proportion—one-third—of the cases in each group with pre-operative cardio-respiratory complications had respiratory symptoms post-operatively. However, in studying the cases individually, it is evident that avertin was used to apparent advantage in several cases with chronic bronchitis, asthma and pulmonary tuberculosis, except in the cases for which ether was also used. Only five of seventeen cases with chronic

AVERTIN ANÆSTHESIA

bronchitis which received avertin without ether were made worse by operation as against two of three ether cases in the control group and two of three avertin-ether cases. Four control cases with chronic bronchitis which had local anæsthesia were not worse after operation. None of the sixteen avertin cases with pulmonary tuberculosis appeared to be aggravated following anæsthesia, while one case in the control group which had a full ether anæsthesia had a very severe reactivation of his pulmonary tuberculosis.

These findings suggest that in some cases which were given avertin basal anæsthesia, the susceptibility to post-operative respiratory complications was reduced. Although these cases are too few in number to permit drawing any definite conclusion from them, it would seem that this reduction, as the reduction in post-operative vomiting, might be largely attributed to the decreased use of ether.

Avertin was used to less advantage in severe cardiacs. Two patients with a severe degree of cardiac disease became much worse after the avertin was given, before any operative procedure was started; and of all the cardiacs in both groups one-third of the avertin group and only one-fourth of the control group were made temporarily worse following operation.

Avertin was also used to less advantage in empyæmas. Of the fourteen empyæma cases in each group, eleven of the avertin cases required gas-oxygen and one ether, while gas-oxygen was required only four times and ether once in the control cases, the remaining nine cases being done satisfactorily under local anæsthesia.

Post-operative Pneumonia and Bronchitis.—As mentioned before, the incidence of post-operative bronchopneumonia and acute bronchitis was considerably lower in the avertin group—in fact just half that of the control cases—as follows:

| | | | |
|----------------------|---|-------|----|
| <i>Control group</i> | | | |
| Bronchitis | 7 | | |
| Bronchopneumonia | 9 | Total | 16 |
| <i>Avertin group</i> | | | |
| Bronchitis | 1 | | |
| Bronchopneumonia | 7 | Total | 8 |

In the control group six of the seven bronchitis cases and seven of the nine pneumonias were not preceded by any pre-operative cardiac or respiratory complaints. Of the other two pneumonias, one had partially decompensated rheumatic heart disease pre-operatively, the other acute pharyngitis complicating toxæmia of pregnancy. All these cases received full ether anæsthesia for a more or less prolonged period. The other case of bronchitis followed a second-stage prostatectomy under local anæsthesia, in an old man of eighty-four years with marked arteriosclerosis and hypertension, and was evidently a purely hypostatic condition. In all except one, of the pneumonia and bronchitis cases in the control group, therefore, the suspicion rests

very strongly on the prolonged ether anæsthesia as being the critical causative factor.

Of the seven avertin cases which developed post-operative pneumonia, five had ether for longer than thirty minutes. Three of these had no pre-operative cardio-respiratory complaints and the other two were cardiacs of moderate degree, one of whom expelled most of the avertin and had practically a full ether anæsthesia. In the majority of these cases also, suspicion is directed toward the ether anæsthesia as the critical etiological agent. The other two cases of pneumonia in the avertin group were rather mild. One developed in a twenty-six-year-old man, with bronchiectasis and chronic asthma, who had an inguinal hernia repaired under avertin and local. The second developed in a woman of seventy-five years with marked arteriosclerosis, who had a simple mastectomy under avertin and gas-oxygen. The one case of bronchitis followed a cholecystectomy under avertin and gas-oxygen in a woman of fifty-two who had an acute upper respiratory infection at the time of operation.

Avertin and Kidney Function.—Avertin was used in twenty-four cases in which kidney operations were performed, *i.e.*, twelve pyelotomies, seven nephrectomies, and five ureterotomies. Because avertin is excreted almost solely by the kidneys, it was thought of interest to study the effect of avertin on kidney function in these cases. Of the thirty-four cases in both groups in which satisfactory data was available, half showed some impairment of kidney function before operation, the other half showed normal function. The proportion of cases showing normal and impaired function pre-operatively was practically the same in the avertin and in the control group. Accurate figures for kidney function immediately after operation were not available, but a fairly good idea of gross kidney function could be obtained from the figures on intake and output. The average pre-operative and post-operative urinary output for the control and the avertin groups was almost exactly the same. The average output for the first twenty-four hours after operation was in both groups approximately 33 per cent. of the output for the twenty-four hours immediately preceding the operation. The average fluid intake was also almost exactly the same in both groups for the first twenty-four hours post-operative.

Judged on the basis of urinary output for a given fluid intake, therefore, following similar kidney operations, the post-operative depression of kidney function was no greater after avertin than after ether anæsthesia; and, as far as could be determined clinically, there was no other evidence of injurious renal effect when avertin was used for kidney operations. However, the marked depression of urinary output which occurred following kidney operations, sometimes lasting forty-eight hours or longer (Table V) meant that the excretion of avertin must in these cases have been proportionately delayed. For this reason, until it is known definitely that the avertin product which is retained in the body is harmless, it would seem wiser not to use avertin for

AVERTIN ANÆSTHESIA

cases with impaired kidney function or for kidney operations where the kidney function is likely to be depressed for several days after operation.

TABLE V
Kidney Function after Kidney Operations

| | Avertin Group | Control Group |
|--|------------------|------------------|
| Normal function pre-operative..... | 54% | 46% |
| Impaired function pre-operative..... | 46% | 54% |
| Average output twenty-four hours pre-operative..... | 57 oz. | 50 oz. |
| Pyelotomies..... | 47 " | 54 " |
| Ureterotomies..... | 61 " | 53 " |
| Nephrectomies..... | 65 " | 37 " |
| Average output twenty-four hours post-operative..... | 19 oz. | 16½ oz. |
| Pyelotomies..... | 20 " | 21 " |
| Ureterotomies..... | 14 " | 11 " |
| Nephrectomies..... | 21½ " | 12 " |
| Percentage post-operative of pre-operative output..... | 33% | 33% |
| Pyelotomies..... | 42% | 40% |
| Ureterotomies..... | 23% | 21% |
| Nephrectomies..... | 33% | 33% |
| Average intake twenty-four hours post-operative..... | 44 oz. | 43½ oz. |
| Pyelotomies..... | 45½ " | 45 " |
| Ureterotomies..... | 52 " | 46 " |
| Nephrectomies..... | 35 " | 38 " |

Avertin and Thyroid Operations.—There was one type of operation for which avertin was considered to be in many ways ideal—namely, thyroid operations. With avertin the pre-anæsthetic excitement and apprehension could be eliminated entirely in most cases and when desired the patient could usually be kept unaware of the time or day of operation, since the pre-operative routine procedure used was almost identical with the procedure followed before basal metabolism. No local preparation was done and no hypodermic given until after the avertin had been administered. In addition the use of ether in thyroid cases was very markedly decreased, ether being used in only seven of the avertin group as against twenty-six of the control group. In all except two of the remainder of the avertin-thyroid cases supplementary gas-oxygen was used, usually without attempting to start the operation under avertin alone.

It was felt that the prolonged sedative effect of avertin might also be of benefit in these thyroid cases, but this was not found to be especially true. In the avertin group, all of which had received thorough pre-operative preparation, a few rather severe post-operative thyroid reactions were encountered which it was felt were more pronounced than might ordinarily be expected. In line with the theory that bromine might displace, or at least conflict with, the action of iodine in the body, it was suggested that the unexcreted bromine

of the avertin might be diminishing the beneficial effect of the Lugol's solution given before and after operation, or in some other way be having a disadvantageous effect on the thyroid-iodine relation. With this in mind a detailed study was made of the temperature reactions during the first five days after operation in all the thyroid cases which received avertin and in a carefully selected control group of thyroid cases. (Table VI.) The number of cases which averaged practically normal temperatures post-operatively—daily average under 100° —was the same in both groups, only nine each. In the remaining cases there appeared to be little difference in the degree of temperature reaction between the avertin and control cases. There were a few more severe reactions in the avertin group but hardly enough to be significant. The slight difference might quite readily be due to other factors. Taking everything into consideration, therefore, there did not seem to be any real evidence that post-operative thyroid reactions were increased in number or degree following avertin, or on the other hand that avertin had any especial beneficial post-operative effect in thyroid cases.

TABLE VI
Temperature Reaction after Thyroidectomies

| | Avertin Group | Control Group |
|---|------------------|------------------|
| Average daily temperature under 100° | | |
| 1st day post-operative..... | 19 | 17 |
| 2nd day post-operative..... | 12 | 12 |
| 3rd day post-operative..... | 16 | 24 |
| 4th day post-operative..... | 29 | 30 |
| Average daily temperature 100° to 101° | | |
| 1st day post-operative..... | 10 | 14 |
| 2nd day post-operative..... | 12 | 10 |
| 3rd day post-operative..... | 15 | 6 |
| 4th day post-operative..... | 2 | 5 |
| Average daily temperature 101° to 103° | | |
| 1st day post-operative..... | 5 | 4 |
| 2nd day post-operative..... | 6 | 12 |
| 3rd day post-operative..... | 1 | 5 |
| 4th day post-operative..... | 0 | 0 |
| Average daily temperature over 103° | | |
| 1st day post-operative..... | 0 | 2 |
| 2nd day post-operative..... | 4 | 0 |
| 3rd day post-operative..... | 0 | 0 |
| Highest average daily temperature under 100° | 9 | 9 |
| Highest average daily temperature over 101° | 14 | 17 |
| Highest single temperature under 100° | 0 | 1 |
| Highest single temperature over 101° | 28 | 23 |
| Highest single temperature over 103° | 6 | 5 |
| Highest single temperature over 105° | 4 | 2 |

AVERTIN ANÆSTHESIA

Avertin Headache and Other Post-operative Complications.—Several patients who had had avertin anæsthesia complained a few hours after operation of a severe headache lasting twenty-four to seventy-two hours. This headache in many instances seemed much more distressing and persistent than the usual type of post-operative headaches. On checking through the nurses notes mention of headache within the first thirty-six hours after operation was found almost twice as frequently in the avertin group of cases (16 per cent.) as in the control group (9 per cent.). In the cases in which this severe headache occurred without other evident cause it seemed probable that it was a toxic after-effect of the avertin (tri-brom-ethyl-alcohol) possibly similar to the well-known hangover headache from ordinary ethyl-alcohol.

Other post-operative complications following avertin anæsthesia, many of them toxic in nature, were noted but not studied in detail. A list of these is given in Table VII. There was only one instance of diarrhœa following the administration of avertin. This was in an eight-year-old girl who had a plastic operation for a scar on the neck. She had watery diarrhœa associated with urinary frequency and urgency for thirty-six hours, after which she had no recurrence of rectal or urinary symptoms. An erosion of the rectum was found at post-mortem twelve days after operation in one case, but since this patient had a pelvic abscess secondary to a ruptured appendix it is improbable that the erosion of the rectum had much to do with the rectal anæsthetic. One patient, a boy of fourteen with Fröhlich's syndrome, who had been operated on under avertin for ingrown toe-nail, developed what appeared to be a bromide rash on the second day post-operative. Several cases showed some mental changes for a few days post-operatively—melancholia, mental confusion, excessive nervousness, *etc.* One patient had an unexplained convulsion, another an unexplained chill, which were thought to be possible reactions from the avertin anæsthetic. There were a few cases of post-operative paralytic ileus which could not be well explained except as post-anæsthetic effects.

Post-operative Mortality after Avertin.—Of the 431 cases in the avertin group twenty-seven, or 6 per cent., died before leaving the hospital as against twenty-four, or $5\frac{1}{2}$ per cent., of the 431 cases in the control group. The slightly larger number of fatalities in the avertin group may be, at least partly explained by the fact that a proportionately larger number of the poor surgical risks were given avertin in preference to other anæsthetics with the idea that it would be a safer anæsthetic. This was especially true during the first twelve months of the eighteen-month period when 8 per cent. of the cases operated under avertin were classified as poor risks and 27 per cent. as fair risks, as compared to the average in the control group of 4 per cent. poor risks, and 16 per cent. fair risks. Of the whole group of 431 avertin cases there were about 10 per cent. fewer good risks than in the control group. Of the avertin cases which died, nine were classified pre-operatively as poor risks as opposed to six in the control group.

Only ten of the avertin cases, or 2.3 per cent. died within forty-eight hours after operation from immediate or delayed post-operative reactions. These

TABLE VII
Other Post-operative Complications
Avertin Group

| Operation | Complication | Result |
|---|---|--------|
| Appendicectomy | Unusually long coma | Rec. |
| Hepatico-duodenostomy | Coma 7 hrs. and post-operative shock | Died |
| Insertion radium cervix | Post-operative chill, deep coma 24 hrs. | Rec. |
| Orchidectomy and hernia repair | Coma 11 hrs. and post-operative shock | Died |
| Exploratory laparotomy | Marked cyanosis, respiratory and circulatory depression | Died |
| Cervical sympathectomy | Marked cyanosis | Rec. |
| Exploratory laparotomy (hepatitis) | Marked cyanosis, coma 8 hrs. | Rec. |
| Thyroidectomy | Marked cyanosis. Acute degeneration liver, kidneys, heart, lungs, <i>etc.</i> | Died |
| Incision abscess groin | Marked respiratory depression, 4 hrs. | Rec. |
| Open reduction | Marked respiratory depression, 4 hrs. | Rec. |
| Cystotomy | Marked respiratory depression, 12 hrs. | Rec. |
| Cholecystotomy | Hypoglycæmic shock, several days | Rec. |
| Cholecystectomy and Posterior Gastroenterostomy | Post-operative shock | Rec. |
| Repair ventral hernia | Post-operative shock and cardiac failure | Died |
| Vaginal repair | Marked post-operative shock | Rec. |
| Vaginal repair | Severe shock, anuria and toxemia | Died |
| Hysterectomy | Post-operative hæmorrhage, 3rd day | Rec. |
| Prostatectomy | Post-operative hæmorrhage, 9th day | Died |
| Thyroidectomy | Post-operative hæmorrhage, 12 hrs. and crisis | Rec. |
| Thyroidectomy | Thyroid crisis and cardiac failure | Died |
| Thyroidectomy | Massive collapse of lung and thyroid crisis | Died |
| Thyroidectomy | Acute pulmonary œdema, 1 hr. post-operative | Died |
| Mid-thigh amputation | Gas-gangrene and acute toxæmia | Died |
| Vaginal and Laparotomy | Very nervous with tremor, 3 days | Rec. |
| Appendicectomy | Melancholia several days | Rec. |
| Excision cyst, breast | Dizziness, 48 hrs. | Rec. |
| Cholecystectomy | Cystitis | Rec. |
| Laminectomy | Cystitis | Rec. |
| Hysterectomy | Cystitis | Rec. |
| Appendicectomy | Cystitis | Rec. |
| Salpingectomy | Pyelitis | Rec. |
| Suspension uterus | Pyelitis | Rec. |
| Hysterectomy | Cystitis and phlebitis | Rec. |
| Cholecystectomy | Phlebitis | Rec. |
| Appendicectomy | Inability to void, 6 days | Rec. |
| Plastic, neck | Frequency, urgency, diarrhœa, 36 hrs. | Rec. |
| Appendicectomy (pelvic abscess) | Paretic ileus, erosion rectum | Died |
| Appendicectomy | Intest. obstruction (? paretic ileus) | Died |
| Cæsarean | Intest. obstruction (? paretic ileus) | Died |
| Nephrectomy | Paretic ileus | Died |
| Appendicectomy | Paretic ileus | Rec. |
| Inguinal hernia repair | Paretic ileus | Rec. |
| Supra-vaginal hysterectomy | Peritonitis | Died |
| Onychectomy | Bromide rash | Rec. |

ten and one other which died on the sixth day post-operative from unexplained persistent paralytic ileus are the only ones in which it was felt that the

AVERTIN ANÆSTHESIA

anæsthesia might be suspected of contributing in any way to the fatality. Of the control group eight died within forty-eight hours post-operative and one other died seventy-two hours after operation with complete anuria which started following operation. All the other deaths in both avertin and control groups occurred from obvious secondary causes or too long after operation to be connected with the anæsthesia. (Table VIII.)

TABLE VIII

Deaths—Avertin Group

- (1) Ruptured Appendix. Died 12th day of peritonitis.
 - (2) Supra-vaginal Hysterectomy. Died 56 hours of peritonitis.
 - (3) Acute Intestinal Obstruction—Internal Hernia. Died 8th day post-operative of unrelieved obstruction.
 - (4) Acute Intestinal Obstruction. Died 5th day of unrelieved obstruction and terminal pneumonia.
 - (5) Strangulated Hernia, 6 days with gangrene and intestinal obstruction. Died 50 hours of recurrent obstruction.
 - (6) Acute appendix. Died 10th day of intestinal obstruction (paralytic ileus).
 - (7) Cæsarean. Died 5th day of intestinal obstruction (paralytic ileus).
 - (8) Prostatectomy. Died 9th day of post-operative hæmorrhage.
 - (9) Prostatectomy. Died 5th day of cardiac failure.
 - (10) Cystotomy. Died 5th day of post-operative pneumonia (avertin expelled).
 - (11) Ulcer of Cæcum. Died 13th day of cardiac failure.
 - (12) Cholecystectomy. Died 40th day of exhaustion following post-operative pneumonia.
 - (13) Exploratory Laparotomy. Died 28th day of chronic leucæmia and terminal pneumonia.
 - (14) Dilatation and Curettage. Died 30th day of multiple sclerosis.
 - (15) Carcinoma of Sigmoid with chronic obstruction. Died 40th day post-operative of cachexia.
 - (16) Supra-vaginal Hysterectomy. Died 21st day, 2 days after second operation (resection of the rectum under spinal).
- Plus eleven deaths discussed in text.

Deaths—Control Group

- (1) Ruptured Appendix. Died 50 hours of peritonitis.
- (2) Ruptured Appendix. Died 68 hours of peritonitis.
- (3) Supra-vaginal Hysterectomy. Died 5th day, peritonitis.
- (4) Thoracotomy, bullet wound abdomen and chest. Died 3rd day, hæmothorax and peritonitis.
- (5) Exploratory Laparotomy (peritonitis). Died 7th day, peritonitis.
- (6) Pyelotomy. Died 5th day, 24 hours after second operation, anuria and uræmia (present before operation).
- (7) Mid-thigh Amputation. Died 56 hours, acute toxæmia.
- (8) Cholecystectomy and Appendicectomy. Died 56 hours from post-operative massive collapse of lung.
- (9) Posterior Gastroenterostomy. Died 3rd day, cardiac failure.
- (10) Cæsarean. Died 15th day, pulmonary embolus.
- (11) Colostomy (carcinoma of sigmoid). Died 3 weeks, 6 days after second operation (cystotomy), cardiac failure.
- (12) Pyelotomy. Died 6 months, œsophageal stricture.
- (13) Diabetic osteomyelitis of foot. Died 3 months after incision and drainage of foot from multiple renal abscesses.

- (14) Nephrectomy. Died 3 weeks, septicæmia with metastatic abscesses.
- (15) Thoracotomy and Mastoidectomy. Died 4 weeks, septicæmia.
- (16) Thyroidectomy. Died 29 hours, thyroid crisis.
- (17) Thyroidectomy. Died 24 hours, thyroid crisis.
- (18) Thyroidectomy (auricular fibrillation). Died 6 hours, cardiac failure.
- (19) Nephrectomy. Died 36 hours, post-operative shock.
- (20) Cholecystectomy and Appendicectomy. Died 29 hours, post-operative shock.
- (21) Supra-vaginal Hysterectomy. Died 24 hours, post-operative shock.
- (22) Supra-vaginal Hysterectomy. Died 2 hours, post-operative shock.
- (23) Supra-vaginal Hysterectomy. Died during operation, "ether narcosis."
- (24) Exploratory Laparotomy (aneurysm). Died 3rd day, anuria and uræmia (post-operative).

A summary in more detail is given below of the eleven deaths in the avertin group mentioned above. Incidentally, it is interesting to note that there happened to be in the control group of cases two deaths which could be said with fair certainty to be due to the anæsthesia—in each case, ether. One of these, a forty-four-old woman, died on the operating table with symptoms of over-etherization and without any signs of circulatory shock or other cause of death; post-mortem showed no cause of death other than ether narcosis. The second, a forty-five-year-old man, who took a poor ether anæsthetic—having a great deal of mucus and cyanosis all during the operation—developed signs of massive collapse of the lung and died fifty-six hours after operation.

In the summaries of these eleven deaths there are several instances of peculiar reactions and of unusual post-mortem findings which were not satisfactorily explained by the patients' disease or by the other findings at post-mortem examination. The question is, could these reactions and pathological changes have been produced by avertin? There are at least three ways in which this relatively "safe" drug might produce harmful effects, *i.e.*: (1) By overdosage; (2) by special susceptibility of a patient to some element of the "avertin fluid," and (3) through the formation in the body, under certain metabolic conditions, of a substance much more irritant and toxic than avertin itself.

Judging from the known physiological properties of avertin, the chief effects of overdosage would be prolonged coma, excessive circulatory depression, and to a less degree respiratory depression. Effects of this type were noted in several of the avertin cases. (Table VII.) None of these cases received doses of higher than 80 to 100 milligrams per kilo, but since the effect of the same dose in different patients varied widely it is quite probable that even the 80 to 100-milligram dose may have been a relative overdose for some patients, especially those weakened by age, shock, cachexia or poor cardiovascular function. The fact that a bromide rash appeared in one patient shows, also, that the possibility of hypersusceptibility to some portion of the avertin solution is more than hypothetical.

As regards the possibility of forming a secondary toxic substance, there would apparently be plenty of opportunity for such formation to occur dur-

ing the period (forty-eight hours plus) of retention of avertin in the body before its excretion. In the normal organism avertin is supposedly "detoxified" by entering very rapidly into a nonirritant combination with glycuronic acid in the liver. If, however, the metabolic or chemical conditions in the body were not suitable for the proper consummation of this protective combination with glycuronic acid—what then? The avertin might remain in the circulation unchanged (which is improbable), or it might be decomposed and form other, possibly more irritating, chemical combinations. It is known that *in vitro* avertin can be rather easily decomposed into such corrosive irritants as hydrobromic acid and di-brom-acet-aldehyde, and there are doubtless other potential decomposition products of similar toxicity. If these can be formed *in vitro*, there is no reason why similar irritants could not be produced in the body. As far as is known, all that stands in the way is a proper functioning of the glycuronic acid metabolism. Perhaps such toxic products in small amounts are formed more frequently than is suspected. If so, it would explain some of the transient, minor—and sometimes not so minor—toxic symptoms noted from time to time in the avertin patients in this group. It would also explain the "mild parenchymatous degeneration" of liver, kidneys and other organs which has been found in experimental animals after repeated administration of avertin.⁵

In discussing the eleven fatal cases in the avertin group these possibilities have been kept in mind. A brief summary and discussion of these eleven cases is given below.

CASE I.—Forty-five-year-old man. Nephrectomy for pyelonephritis and renal calculus, 80-milligram dose of avertin supplemented by gas-oxygen and a very small amount of ether. After operation a paralytic ileus developed which failed to respond to treatment. Ileostomy performed on fifth day under local novocaine anæsthesia. Ileus unrelieved. Died thirty-six hours later in acute toxæmia with terminal cardiac exhaustion. Post-mortem showed usual signs of terminal cardiac failure but no peritonitis or other cause for the ileus.

What caused this very persistent ileus? Post-mortem examination showed no peritoneal infection and no organic obstruction. The patient was not uræmic. In the group of 431 avertin cases there were several instances of less marked paralytic ileus, apparently caused by the avertin anæsthetic. It is possible, therefore, that the ileus in this case might have been a post-avertin (toxic) effect—especially since it followed a nephrectomy, an operation in which kidney function—and hence avertin excretion—is more than usually disturbed.

CASE II.—Forty-eight-year-old woman. Hepatico-duodenostomy for biliary fistula and atresia of the common duct, 80-milligram dose of avertin supplemented with gas-oxygen. Before operation patient was markedly cachetic and a poor operative risk. The operation was very difficult lasting three and one-half hours, during the last two hours of which the patient was in shock with imperceptible pulse. Remained in shock and died seven hours after operation without regaining consciousness. Post-mortem refused.

This death was definitely due to profound operative shock. The fact

that the patient did not regain consciousness before death seven hours after operation, however, suggests that the depressant effect of the avertin was much prolonged in the presence of the marked shock and cachexia. The 80-milligram dose which would be well within the margin of safety for an average person appeared to be an overdose for this patient. How much effect it may have had in depressing whatever slight rallying powers this patient had is problematical. The chief cause of death of course was very definitely the shock of the operation.

CASE III.—Fifty-nine-year-old woman. Exploratory laparotomy and cholecystotomy for fluid in abdomen, avertin supplemented by local anæsthesia. Patient was a very poor risk with a bad cardiac history and showed signs of considerable cardiac insufficiency at time of operation. After the avertin had been given the patient became quite cyanotic with marked respiratory and circulatory depression before any operative procedure was attempted. At operation gallons of ascitic fluid escaped and several large gall-stones which were pressing on the portal vein were removed. The patient was in shock during and after the operation and died two hours post-operatively still markedly cyanotic and depressed without regaining consciousness.

CASE IV.—Forty-five-year-old woman. Repair of massive incarcerated ventral hernia causing acute intestinal obstruction, 80-milligram dose of avertin with a small amount of gas-oxygen. Patient obese and toxic. Moderate shock with pulse of 130 at end of operation. Six hours later began to be very restless and cyanotic with signs of cardiac decompensation developing. Intravenous digitalization and glucose produced no improvement and the patient died ten hours after operation.

Both these cases were definitely deaths from cardiac failure precipitated by operative shock with no special incident to attract attention to the anæsthesia; although, as mentioned above, avertin, because of its depressant effect on the circulation, would not seem to be a good anæsthetic to use in the presence of poor cardiovascular function.

CASE V.—Seventy-five-year-old man. Orchidectomy and herniorrhaphy for right infected hydrocele and inguinal hernia, 100-milligram dose of avertin supplemented with gas-oxygen. Only a fair surgical risk having arteriosclerotic heart disease with considerable myocardial damage as shown by electro-cardiogram. Condition at end of operation was considered good, but subsequently could not be aroused from anæsthetic. In a few hours became cyanotic, showed signs of cardiac failure, and died eleven hours after operation without regaining consciousness. Post-mortem showed moderate arteriosclerosis of heart and kidneys, chronic emphysema, and a light, yellowish-brown liver showing signs of chronic degeneration. Pathologist's report: "The cause of death is not apparent at post-mortem."

This death might also be classified as a death from cardiac failure. But, as in Case II, the question arises, why did the patient not regain consciousness before death eleven hours after operation? If this profound coma were produced by the avertin what assurance is there that the rest of the post-operative picture with its fatal result was not also in large measure due to the anæsthetic? The chronic degeneration of the liver found at autopsy might indicate inability of the liver to carry out normal avertin detoxification. Arteriosclerotic degeneration of the kidneys was also present which may well have had a marked effect on avertin excretion.

AVERTIN ANÆSTHESIA

CASE VI.—Eighty-two-year-old man. Mid-thigh amputation for arteriosclerotic gangrene of right foot, 80-milligram dose of avertin supplemented with gas-oxygen and a very small amount of ether. A rather poor surgical risk with arteriosclerotic heart disease and auricular fibrillation. Blood chemistry however was normal (urea 26, creatinin 1.9, sugar 96) and kidney function good (P.S.P. 60 per cent. in two hours). At end of operation went into shock from which he rallied quickly with treatment but continued drowsy, restless, and mentally confused. Twenty-four hours after operation his temperature rose sharply to over 103° , he became rapidly more toxic and died in coma twelve hours later. At this time the edges of the wound were foul, necrotic, and black with a moderate degree of gas crepitus. Post-operative urinary output was adequate—62 ounces in thirty-six hours. There seemed to be a slight degree of jaundice.

The clinical impression was that death was due to gas gangrene of the operative wound with secondary acute toxæmia. It was felt, however, that the rapid severe course of the toxæmia was out of proportion to the degree of infection, and the possibility of an added effect due to improperly detoxified avertin was considered. The slight jaundice suggested liver damage. Since post-mortem examination was refused there was no opportunity to check on these possibilities.

CASE VII.—Seventy-three-year-old woman. Sub-total thyroidectomy for enlarged thyroid with hyper-thyroidism, 80-milligram dose of avertin supplemented with gas-oxygen. Had a large nodular thyroid with considerable tracheal pressure symptoms, moderate hyperthyroidism, and auricular fibrillation. Operation was done after two weeks' rest in bed and one week of Lugol's solution with marked improvement. A moderate thyrotoxic reaction occurred during the first twenty-four hours after operation which became rapidly more severe during the second day. Died forty hours post-operatively from cardiac failure with a terminal temperature of 107.4° . Post-mortem showed chronic myocardial degeneration, pulmonary œdema, and œdema with small hæmorrhagic areas in the mediastinum.

CASE VIII.—Fourteen-year-old girl. Sub-total thyroidectomy for Graves' disease, avertin, with gas-oxygen. Pre-operative condition did not improve with rest in bed and medication with Lugol's solution. Operation done two weeks after admission to hospital. Twelve hours after operation developed signs of massive collapse of right lung with marked displacement of heart and mediastinum, causing obstruction of venous return. Right pneumothorax, produced artificially, gave some relief but, although respirations were easier, temperature and pulse continued to rise and patient died forty-six hours after operation with symptoms of marked acute thyrotoxic reaction and terminal cardiac failure.

Death in both these cases was definitely due to post-operative thyroid reactions, complicated in one case by severe heart disease and in the other by post-operative massive collapse of the right lung. There was no suggestion that the anæsthesia had anything to do with either of these fatalities.

CASE IX.—Thirty-seven-year-old woman. Sub-total thyroidectomy for Graves' disease, 100-milligram dose of avertin supplemented with gas-oxygen and ether mixture. Operated on after nine days in the hospital. During operation had a lot of mucus in throat, necessitating use of suction. Was cyanotic with much mucus in throat on return to bed but condition otherwise good. Developed a moderate thyrotoxic reaction; also started to cough a few hours after operation. Day after operation cough increased and T.P.R. began to rise higher. Thirty-six hours post-operative became very lethargic, difficult to arouse, urinary output decreased—7 ounces first twelve hours post-operatively, 6 ounces next twenty-four hours, and $\frac{1}{2}$ ounce next twelve hours (catheterized). In

spite of glucose infusions, clyses, fluids forced by mouth, and diuretic medication (diuretin), she sank deeper into coma, respirations became labored, and circulation weaker. Died in coma forty-six hours after operation. Post-mortem showed a confluent lobular pneumonia, marked acute tubular degeneration of the kidney, very extensive acute degenerative and hæmorrhagic necrosis of the liver, areas of focal necrosis in the myocardium, and a large persistent thymus.

The post-mortem changes found in this case—extensive acute necrosis in liver, kidneys, heart, and lungs—can only be explained as due to the action of some potent corrosive irritant. In view of the clinical history this irritant must have been introduced into the body at the time of, or shortly after, operation. It seems almost certain that the source of this toxic irritant in this patient must have been the avertin anæsthetic. It seems especially significant that the post-mortem findings in this case were almost identical with post-mortem changes reported recently by Hare and Wright⁸ in describing a fatal case following avertin narcosis in a cat. The cat described reacted normally for the first few hours after operation, as did this patient, and died in about twenty hours, post-mortem showing generalized acute necrosis of the liver, acute degeneration of the kidneys, diffuse œdema of the lungs with a patch of acute bronchopneumonia, and subendocardial hæmorrhages.

CASE X.—Twenty-seven-year-old woman. Sub-total thyroidectomy for Graves' disease, 100 milligrams dose of avertin supplemented with gas-oxygen. A moderately toxic colored woman admitted with a basal metabolism of plus 20 which jumped to plus 32 after about a week's rest in bed. After two and one-half weeks' rest in bed and ten days medication with Lugol's solution, she seemed in good condition for operation. Fifteen minutes after start of operation, pulse rose suddenly from 100 to 160 then fell to 140. The operation was continued with the pulse ranging from 150 to 170, bounding quality, respirations rapid. Condition poor at end of operation. One hour later pulse became imperceptible and lungs filled up with œdema. Patient died with symptoms of acute cardiac failure and pulmonary œdema one and one-half hours after operation with rectal temperature of $102\frac{1}{2}^{\circ}$. Post-mortem showed marked acute pulmonary œdema with considerable fresh pleural effusion, very marked acute congestion of all the viscera (noted to be much more than usual post-mortem congestion), sub-endocardial hæmorrhages in the heart, and a large, persistent thymus.

The sudden acute cardiac failure and pulmonary œdema in this case may have been part of a fulminating thyroid reaction. The points against such an interpretation are: (1) This was not the type of thyroid case in which such reactions usually occur—the patient was not severely thyrotoxic and had had thorough pre-operative treatment with rest, sedatives, and Lugol's solution; (2) the circulatory breakdown started very early in the operation when there had been little operative shock or trauma to the thyroid gland, and (3) the patient's pre-operative cardiac status was excellent as demonstrated by medical consultation and electro-cardiographic study.

The severity and the unexpectedness of the fatal reaction in this case suggested that some unusual factor was involved and, having only a few hours before viewed the post-mortem on Case IX, suspicion was naturally directed toward the avertin anæsthesia. In a hypersusceptible patient avertin might

AVERTIN ANÆSTHESIA

readily cause sufficiently marked depression of the circulation to have caused the sequence of events causing this death. It was suggested that the unusual degree of visceral congestion and the subendocardial hæmorrhages might represent the earliest stages of an acute necrotic process similar to that found at post-mortem in Case IX.

Since patients IX and X both died on the same day, the possibility of the stock solution of avertin having deteriorated was considered but the solution was checked on many other cases both before and after without any ill-effects being observed. The persistent thymus in both cases was believed not to be significant except as a glandular condition associated with the thyrotoxic state. Neither death was of the thymic type.

CASE XI.—Thirty-three-year-old woman. Vaginal repair with interposition and sterilization, 100-milligrams dose of avertin supplemented with gas-oxygen and ether mixture. Patient appeared to be a normal, healthy young woman before operation and her condition during and at the end of the operation was good. Two hours later she appeared to be in some shock and was very restless, talkative, and mentally confused. Her color was a peculiar combination of pallor and cyanosis. She continued very restless and developed a marked psychosis. There were no signs of intraperitoneal hæmorrhage or infection. The severity of her symptoms was slightly relieved for short intervals by intravenous infusions and by a transfusion, but in spite of all treatment temperature and pulse gradually rose with associated weakening of the circulation and she died in semi-coma and circulatory collapse thirty hours after operation, with a terminal temperature of 106.4° and pulse of 170. The respirations remained normal and there were no signs of pulmonary pathology. Only 3 ounces of urine (catheterized) were obtained in thirty hours in spite of several infusions, a large clysis, and a transfusion.

The cause of death in this case was obscure. There were no signs of peritoneal hæmorrhage or infection, or of pulmonary embolism. The process was too fulminating to be a purely uræmic death secondary to kidney shut-down. There was no evidence of hyperthyroidism.

There was obviously a severe degree of toxæmia and shock which affected especially the kidneys and cardiovascular system and which was not relieved by the usual therapy. The only origin for this toxæmia which could not be ruled out with fair certainty was the avertin anæsthesia. Unfortunately, post-mortem examination was refused so that the pathology back of this patient's symptoms could not be determined.

In two or three of these eleven cases, therefore, it seems quite possible—in Case IX quite probable—that the avertin was at least partly responsible for the fatal outcome. In several of the other cases there were indications that the avertin had had some adverse effect which may or may not have contributed considerably to the fatality. The evidence of the guilt of avertin is not in any of the cases completely convincing, but it is suggestive enough to strengthen the feeling that avertin is not quite as safe and completely harmless an anæsthetic as many of its proponents believe, and that it should be used with caution until more is known about the chemical and physiological properties of the various decomposition products and chemical combinations which may be produced by it in the body under varying conditions.

Summary.—A study was made of 431 surgical cases which were given avertin anæsthesia over an eighteen-month period at the Brooklyn Hospital. These cases were compared with 431 similar surgical cases given other types of anæsthesia at the same hospital.

The preparation of avertin used was "Avertin Fluid" (Winthrop), a composite drug containing tri-brom-ethyl-alcohol (avertin) and amylene hydrate in solution. In most of the cases the aim was to use this solution as a basal anæsthetic only—that is, to produce unconsciousness and amnesia during the pre-operative and operative period without necessarily producing complete pain insensibility or muscular relaxation. Morphine and atropine were usually given by hypodermic before the avertin, producing a smoother basal anæsthesia without noticeable harmful effect.

Doses varying from 60 milligrams per kilo to 100 milligrams per kilo were used. The larger doses produced unconsciousness more rapidly and for a longer time than the smaller doses, and required less supplementary anæsthesia, especially ether. On the other hand, the larger doses occasionally produced symptoms of overdosage such as excessive circulatory depression or prolonged coma, especially in patients weakened by chronic illness, age, cachexia, shock, *etc.* In addition, in some cases, various toxic reactions were noted post-operatively which it was difficult to explain except as sequelæ of the avertin anæsthetic. In several cases symptoms of overdosage or unusual toxic manifestations were followed in a few hours by death. One of these cases showed at post-mortem extensive acute necrosis of liver, kidneys, heart and lungs evidently caused by a strong corrosive irritant for which no source could be determined other than the avertin which had been administered for basal anæsthesia in dosage of 100 milligrams per kilo.

The immediate post-operative course was in general more pleasant from the patients point of view, but the need for special nursing care was increased because of the irresponsibility of the patients during the long period of awakening from the anæsthesia. Post-operative vomiting and to a less degree post-operative respiratory complications were decreased in the avertin patients. This decrease appeared to be largely attributable to the decreased amount of ether used when avertin was given.

The effect on kidney function following kidney operations performed with avertin basal anæsthesia was investigated. The usual marked decrease in output during the first two or three days post-operative was found but this was not more marked than the decrease in output in the control cases which had similar operations.

The possibility of a good or bad effect of avertin on thyroid reactions following thyroidectomy was considered but no difference was found between the severity of reactions in the avertin and the control cases. With avertin, however, pre-operative apprehension and excitement were entirely abolished and the patient could be kept unaware of the time of operation, if desired.

AVERTIN ANÆSTHESIA

ADVANTAGES AND DISADVANTAGES

As a result of these findings we would list the advantages and disadvantages of avertin as follows:

ADVANTAGES.—Pre-operative.—(1) Can be administered in bed without discomfort. Induction resembles natural sleep.

(2) In cases of hyperthyroidism, emotional instability, *etc.*, pre-operative excitement can be abolished by having patients' nurse give the avertin as if it were an ordinary enema.

Operative.—(1) When supplemented with gas-oxygen, satisfactory anæsthesia and muscular relaxation can often be obtained for many major surgical operations which usually require deep ether anæsthesia, including laparotomies and orthopædic manipulations.

(2) When ether is needed in addition to the gas-oxygen, the amount required is markedly reduced.

Post-operative.—(1) Amnesia is usually produced covering the operative and early part of the post-operative period.

(2) Immediate post-operative distress is in many cases considerably decreased due to (a) prolonged drowsiness; (b) decreased vomiting; (c) decreased respiratory irritation; (d) decreased "ether taste."

DISADVANTAGES.—Pre-operative.—(1) Solution must be freshly prepared for each case and carefully tested for proper temperature and acidity.

(2) When once administered, dosage cannot be decreased because of rapidity of absorption.

(3) Length and variability of induction period may delay the operating schedule.

Operative.—(1) Depth of anæsthesia with a given dose is uncertain and variable. For this reason cannot be satisfactorily used to avoid the use of ether (as when electrocautery is used for head or chest operations, *etc.*).

(2) Is unsatisfactory when used with local or regional anæsthesia because patient is uncoöperative while retaining power of motion and speech.

(3) Anæsthesia cannot be lightened if patient's tolerance decreases, as in the event of serious hæmorrhage or operative shock.

Post-operative.—(1) Prolonged post-operative special nursing is required because of long period of semi-coma and irrational restlessness.

(2) Excretion is slow and is almost solely through the kidneys. Kidney output is frequently diminished markedly after operation, making excretion even slower.

(3) The wide variation in susceptibility to avertin and narrow margin between the therapeutic and the toxic dose results in the occasional occurrence of toxic symptoms, and even death, after moderate doses (100 milligrams per kilo or less).

Conclusions.—We feel, after studying these 431 cases of avertin administration and the 431 controls, that "Avertin Fluid" used as a basal anæsthetic in combination with gas-oxygen or gas-oxygen and ether has some advantages not possessed by most other anæsthetics and that accordingly it has a distinctly useful place in the roll of anæsthetics. There are, on the other hand, several definite disadvantages which must be considered in selecting avertin for any given case.

The occurrence of toxic and overdosage symptoms in several of our cases, with at least one fatality, after the administration of doses of 100 or 80 milligrams per kilo, indicates to us that this dosage is not entirely safe for routine use. We feel that the 80-milligram and 100-milligram doses have no important advantage over the 60 to 70-milligram dose and are considerably

more dangerous. The 60 to 70-milligram dose, especially when combined with a pre-operative hypodermic of morphine, usually produces the essentials of a basal anæsthesia. When this is inadequate, there is no objection to giving a small additional dose of avertin after the effect of the initial dose has been fully observed.

The occasional production of complete anæsthesia by the larger doses is, we believe, by no means an advantage, indicating rather an overdose with the associated greater risk. We feel, also, that any slight increase in the patient's comfort which may follow the use of larger doses is greatly outweighed by the increased liability to overdosage and to toxic reactions. We would prefer to use avertin only to obtain the minimal satisfactory basal anæsthesia and to complete the anæsthesia with gas-oxygen or, when necessary, ether. More ether seems safer than more avertin.

We consider certain conditions to be absolute contra-indications to the use of avertin—at least until more is known about the chemistry of detoxification and excretion of avertin in the body. In the presence of any of these contra-indications we would not consider even the 60-milligram dose safe to use.

Foremost among contra-indications we would place any condition lowering liver function. This would include not only intrinsic pathology of the liver and its ducts, but also circulatory insufficiency with consequent liver congestion and any condition associated with marked depletion of glycogen. Any evidence of decreased kidney function should be considered of almost equal importance as a contra-indication. This means not only evidence of decreased function before operation as demonstrated by urine and blood tests, but also the probability of function being decreased more than usual following operation due to such causes as trauma to the urinary tract, post-operative shock, post-operative dehydration, *etc.* A review of the fatal cases discussed above shows that in many of them there was evidence of impaired liver or kidney function and in some of them, primary disease of these organs.

As other contra-indications we would include:

(1) Severe cardiac disease—because of the depressant effect of avertin on the circulation and because of the congestion of liver and kidneys associated with poor cardiac function.

(2) Old age—because old people are often hypersusceptible to avertin and because of senile and arteriosclerotic changes usually present in liver and kidneys.

(3) Cachexia—because of the probability of lowered tolerance for all drugs, including avertin, and because of the usually poor glycogen metabolism.

(4) Marked shock or dehydration—primarily because of effect on kidney function.

(5) Marked acidosis or acute toxæmia—because of disturbance of body chemistry and metabolism which may have a harmful effect on avertin detoxification. It is a question if severe thyrotoxicosis should not also be included in this group.

By adhering to these contra-indications and by using the 60 to 70-milligram dose rather than the larger doses, we feel that in the future we may prevent many undesirable reactions and avoid any avertin fatalities.

REFERENCES

- ¹ Parsons, F. B.: Brit. Med. Jour., vol. ii, p. 709, 1929.
- ² Reed, C. B.: Am. Jour. Surg., vol. ix, p. 77, 1930.
- ³ Straub, W.: München med. Wchnschr., vol. lxxv, p. 593, 1928; *Ibid.*, vol. lxxv, p. 1279, 1928.
- ⁴ Eicholtz, F.: Deutsch. med. Wchnschr., vol. liii, p. 710, 1927; *Ibid.*, vol. lv, p. 1457, 1929, and ff.
- ⁵ Raginsky, B. B., Bourne, W., and Bruger, M.: Jour. Pharmacol and Exper. Therap., vol. xliii, p. 219, 1931.
- ⁶ Bourne, W., and Raginsky, B. B.: Am. Jour. Surg., vol. xiv, p. 653, 1931.
- ⁷ Waters, R. M., and Muehlberger, C. W.: Arch. Surg., vol. xxi, p. 887, 1930.
- ⁸ Hare, T., and Wright, G.: Proc. Roy. Soc. Med., vol. lv, p. 242, 1931.

BIBLIOGRAPHY OF LITERATURE ON AVERTIN FATALITIES

- Gossman, J. R.: Zentralbl. f. Chir., vol. lv, p. 395, 1928.
- Schrodl, P.: Zentralbl. f. Chir., vol. lv, p. 1231, 1928; Comment by Nestmann: *Ibid.*, vol. lv, p. 1805, 1928; Comment by Kohler: *Ibid.*, vol. lv, p. 1806, 1928.
- Pfitzner: Klin. Wchnschr., vol. viii, p. 409, 1929.
- Kallman, D.: Deutsch. med. Wchnschr., vol. lv, p. 1221, 1929.
- Pribram, B. O.: Zentralbl. f. Chir., vol. lvi, p. 1164, 1929.
- Dressen, J.: Zentralbl. f. Chir., vol. lvi, p. 2202, 1929.
- Burk, W.: Zentralbl. f. Chir., vol. lvi, p. 2204, 1929.
- Kotzoglou, P.: Zentralbl. f. Chir., vol. lvi, p. 2206, 1929.
- Specht, K.: Zentralbl. f. Chir., vol. lvi, p. 2213, 1929.
- Karber, G., and Lendle, L.: Arch. f. exper. Path. u. Pharmacol., vol. cxlii, p. 1, 1929.
- Nordmann, O.: Chirurg., vol. i, p. 1142, 1929.
- Glaesner, E.: München med. Wchnschr., vol. lxxvi, p. 2089, 1929; Comment by Killian: *Ibid.*, vol. lxxvii, p. 227, 1930; Reply by Glaesner: *Ibid.*, vol. lxxvii, p. 541, 1930.
- Killian, H.: München med. Wchnschr., vol. lxxvii, p. 941, 1930.
- Lendle, L.: Deutsch. med. Wchnschr., vol. lvi, p. 779, 1930; Comment by Gros: *Ibid.*, vol. lvi, p. 780, 1930; Reply by Eicholtz: *Ibid.*, vol. lvi, p. 1172, 1930; Reply by Gros: *Ibid.*, vol. lvi, p. 1172, 1930.
- Hoepfl: München med. Wchnschr., vol. lxxvii, p. 1756, 1930.
- Lendle, L., and Tinger, H.: Klin. Wchnschr., vol. ix, p. 1293, 1930.
- Gutig, K.: Beitr. z. klin. Chir., vol. cli, p. 585, 1931.
- Schuberth, O.: Acta chir. Scand., vol. lxxviii, p. 55, 1931. (Review of literature on deaths.)
- Zeno, A., Cames, O., and Ferrer, J.: Bol. y. trab. de la Soc. de cir. de Buenos Aires, vol. xv, p. 531, 1931.
- von Scanzoni, C.: Zentralbl. f. Chir., vol. lviii, p. 2251, 1931.
- Schonbauer, L., and Links, R.: Zentralbl. f. Chir., vol. lix, p. 941, 1932; Comment by Tiernann: *Ibid.*, vol. lix, p. 943, 1932.
- Benecka, E.: Centralbl. f. allg. Path. u. path. Anat., vol. liv, p. 81, 1932.
- Laforet, C. C.: Rev. espan de obst. y. ginec., vol. xvi, p. 738, 1932.

TRANSACTIONS

OF THE

NEW YORK SURGICAL SOCIETY

STATED MEETING HELD MAY 11, 1932

The President, DR. JOHN DOUGLAS, in the Chair

FIBROMA OF THE STOMACH

DR. ROBERT H. KENNEDY presented a woman, aged sixty-three, who was admitted to Stuyvesant Square Hospital June 19, 1930, complaining of belching of gas and vomiting. There was no history of cancer in her family. Seventeen years previously a tumor had been removed from the hip region, nature unknown. Her past history was otherwise irrelevant.

For two years before admission she had had a sour taste in her mouth with belching of considerable gas after eating. She felt that she could not eat much at a time and had not eaten meat for the past six months. About six months before admission she consulted a physician for the first time. For several months past she had vomited frequently immediately after eating. She had never had any pain and had lost but four pounds in weight. She was in fairly good general condition with no palpable abdominal masses nor tenderness. The X-ray following a barium meal showed an obstruction to the passage of barium apparently 1 inch to the left of the spinal column with marked six-hour retention and some twenty-four-hour retention. There was no filling defect seen in any picture nor in the fluoroscopic examination. Gastric analysis showed no free hydrochloric acid present and a total acidity of forty-six. The benzdine test was positive and no lactic acid was found.

Operation June 25, 1930, under colonic ether. Median upper abdominal incision. Nothing was felt in the anterior wall of the stomach. A movable mass was felt posteriorly $2\frac{1}{2}$ by 1 inches in diameter. The distal margin extended to within 3 inches of the pylorus. A 2-inch vertical incision was made through the anterior wall of the stomach about midway between the lesser and greater curvatures. The tumor was freely movable beneath the mucous membrane of the posterior wall. There was no pedicle. A $1\frac{1}{2}$ -inch incision was made through the mucous membrane of the posterior wall over the mass which was dissected out bluntly. It lay between the mucosa and serosa near the greater curvature. Its consistency was that of a uterine fibroid, well encapsulated and divided into three lobules. It had evidently acted as a ball valve, even though there was not a pedicle. The mucous membrane was sutured with continuous chromic gut. The anterior wall of the stomach was closed by two layers of sutures and a tab of omentum was sutured over this line. The patient made an uneventful post-operative recovery.

Microscopical examination showed interlacing bundles of fibroblasts with œdema. It is now twenty-two months since operation. The patient has no complaints and is on a regular diet.

According to Lockwood nearly a thousand cases of benign tumor of the stomach have been reported. The incidence varies from 1 to 5 per cent. of all

CONGENITAL FISTULA OF THE NOSE

growths of the stomach. Single tumors predominate and the majority are less than 1 inch in diameter.

CONGENITAL FISTULA OF THE NOSE

DOCTOR KENNEDY presented a boy, three years of age, who was admitted to the Stuyvesant Square Hospital February 5, 1932, on account of a discharging area on the right side of the nose near the root. His mother stated that about a year and a half previously she noticed a pimple on the right side of his nose. In a short time this opened, discharged a small amount of pus and then scabbed over. This process was repeated several times. The patient was said to have had a "running nose" from birth. The father and mother were healthy and no abnormalities known of in them, their relatives, nor their one older child.



FIG. 1.



FIG. 2.

FIG. 1.—Congenital fistula of the nose. Note the upper opening on right side of the base of the nose; the lower opening on the under surface of the tip of the nose. The lower opening, the size of a pin point, has been emphasized by a ring of ink to mark its location.

FIG. 2.—X-ray photograph of lipiodol injection of congenital fistula of the nose. Note depth beneath the nasal bone.

Examination showed a healthy child with a scabbed-over area on the right side of the nose 1 centimetre in diameter. This was slightly raised above the surface and had no reaction about it. There was no discharge at this time. It suggested an infected granuloma, possibly from a foreign body. The testicles were not found in either inguinal canal nor in the scrotum. A dimple was present over the apex of the sacrum, but no opening was made out. Otherwise no abnormalities were found.

The scab was removed and an attempt made to inject methylene blue through a small opening beneath. It seemed to hold practically nothing. A probe could be inserted mesially and upward for a distance of 1.5 centimetres. The cavity was entirely surrounded by bone. It seemed probable that ethmoid cells had been entered. However, a swab inserted in the right

nostril failed to show any methylene blue, but on withdrawing this the pressure on the nostril caused a minute bead of blue color to appear on the under surface of the tip of the nose in the median line. The opening was pin point in size.

X-rays taken after injection of lipiodol in the upper opening showed a tract extending mesially and slightly upward, then downward in the median line to the tip of the nose. The middle portion of the tract appeared to be at a depth which would place it just under the mucous membrane of the nose. The accessory sinuses were negative. It seemed that it might be possible to excise each end of the tract through skin incisions and the middle portion through the inside of the nasal cavity. (Figs. 1 and 2.)

February 11, 1932, under colonic avertin anaesthesia, supplemented with ether, the tract was excised. Methylene blue was first injected into the upper opening. Attempts to introduce fine metal probes into the lower opening were not successful beyond 1 inch. A ureteral filiform was then inserted for over 2 inches. It could not be felt through the upper opening, nor through the mucous membrane of the nose. Therefore, an incision was made in the median line for practically the entire length of the dorsum of the nose and encircling the lower opening. The tract passed upward superficially for a short distance to what was apparently the junction of the medial crura of the greater alar cartilages with the cartilage of the septum. Here it dipped into the septum. The septal cartilage was incised from this point upward to the nasal bones and these were cut through in the medial line for about 1 centimetre with chisel and hammer. It was then evident that the tract lay in a canal completely surrounded by cartilage or bone throughout its extent, *i.e.*, between the walls of an incompletely united septum. With the filiform in place, it was possible by sharp dissection to separate the tract from its surrounding cartilage and bone up to its upper expansion. This portion, on removal, measured 6 centimetres in length. The upper opening was then excised with the tissue surrounding the opening into bone. This opening was about 5 millimetres in diameter. On enlarging it, a cavity in bone was found beneath, 1.5 centimetres in diameter, with a very thin lining. The fistulous tract entered this at such a sharp angle that it was impossible to push the filiform up into this space, even though its point could be seen. This upper expanded portion was simply curetted. Both wounds were closed without drainage. At no time during the operation was there any suggestion of blood within the nose. The boy was discharged on the seventh day post-operative with both wounds healed.

Microscopical examination of the tract showed a lining of epidermis with underlying skin structure and hair follicles. No hair was found lying in the fistula.

From the material published on congenital fistula of the nose or dermoid cysts of the nose, this would seem to be a rare condition. In 1912 Oyez, of Lille, reports in detail on thirty cases which he found in the literature and added two of his own. The earliest reference found was by Lawrence, who reported two cases in 1837. Hart, in a later report, was able to find eight other cases before 1912. Eight authors have written on this subject since 1912: three German, three Dutch, one Italian and one American. Six of these articles report nine cases. This makes a total of forty-nine cases which the reporter had been able to find previously reported.

TRANSPLANTATION OF BILIARY FISTULA INTO STOMACH

Among the patients cited by Oyez, the fistula in one of Bramann's cases admitted a probe from the junction of the cartilage and the nasal bones to the base of the nose, but the tract was not excised. Cruvielhier had a similar case which was not operated on. Two others passed deeply into the bone but not over half an inch in length. In seven other instances it is mentioned that the tract was densely adherent to bone and one wonders if in some it did not pass more deeply but was unrecognized with the facilities at hand. Of the more recent cases, all the tracts seem to have been quite short except in one reported by Vermeulen and one by Trampnau. Both of these had lipiodol injections and are quite similar in extent to the case reported here. Trampnau's case had a tract 4 centimetres long. Hart in 1927 reported the only case which has been published in the United States. This showed a tract running the length of the nasal bone, but no bone involvement was demonstrated.

It is possible that these cases may be more common than the number of reports shows. With lipiodol injections it is probable that more of the tracts will be found running deeply in cartilage or bone. With the possible exception of Vermeulen's patient, the tract in the case presented is the longest on record, 7.5 centimetres.

J. Bland Sutton gives the following explanation of the origin of this abnormality:

In the early embryo, the rudiment of the nose is represented by that process of the primitive skull which is known as the fronto-nasal plate. This is separated from the lateral portions of the face by the orbito-nasal fissures. The rounded angles of the fronto-nasal plate are known as globular processes. Each process forms a portion of the ala of a nostril and the corresponding premaxilla. These processes fuse in the middle line and give rise to the central median piece (philtrum) of the upper lip. Dermoids of the nose are invariably situated in the line of the internasal groove and are in all probability due to incomplete fusion of the globular processes.

TRANSPLANTATION OF BILIARY FISTULA INTO STOMACH

DR. W. HOWARD BARBER presented a man, thirty-four years of age, who entered Bellevue Hospital September 30, 1931. He was in a wretched physical condition, reduced to 105 pounds in weight. He had had a cholecystectomy and appendectomy performed in another hospital in July and since that time had persistently drained bile from the upper extremity of the wound. Stools had been a light yellow. Had suffered from diarrhoea, having eight to ten watery stools a day. Anorexia and gaseous eructations were other digestive symptoms complained of. He presented an upper 8-inch right rectus scar with a biliary fistula at its upper extremity. Blood showed a slight secondary anaemia and a negative Wassermann. Urine negative. Van den Bergh direct and indirect negative. X-ray examination revealed a dilated stomach adherent to the right with a 75 per cent. retention at end of six hours. Lipiodol injection revealed dye in bile-ducts. At operation under spinal anaesthesia, October 14, 1932, a fistulous tract was found adherent to liver, stomach, and great omentum. (Figs. 3 and 4.) No stone was palpated nor was it possible to determine the pathological condition of the ducts. The

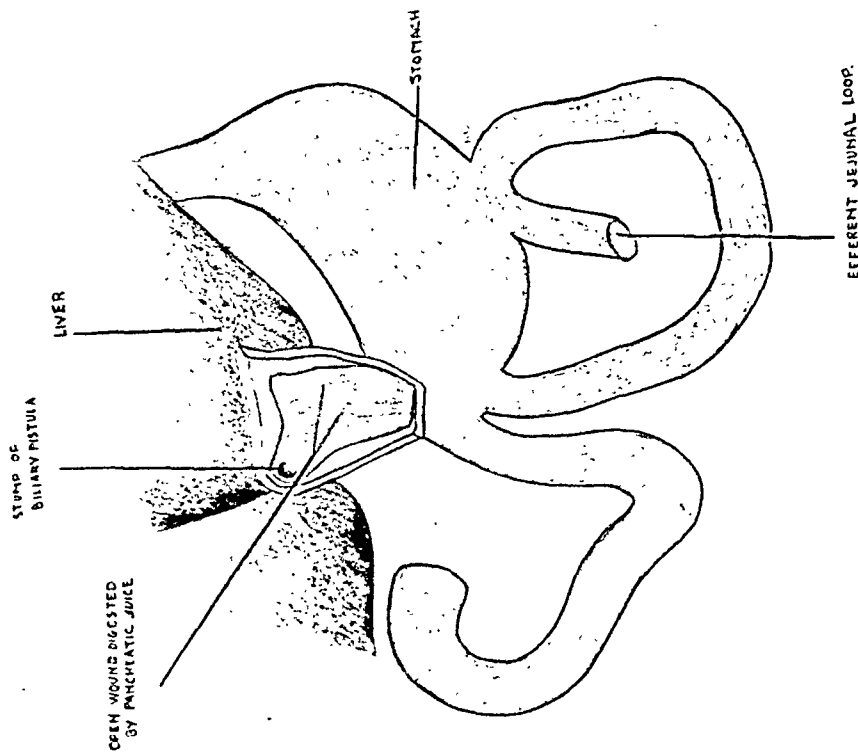


FIG. 3.—Semi-diagrammatic post-mortem drawing illustrating condition of patient with biliary fistula upon admission to Hospital. Failure followed attempted transplantation of fistula into duodenum.

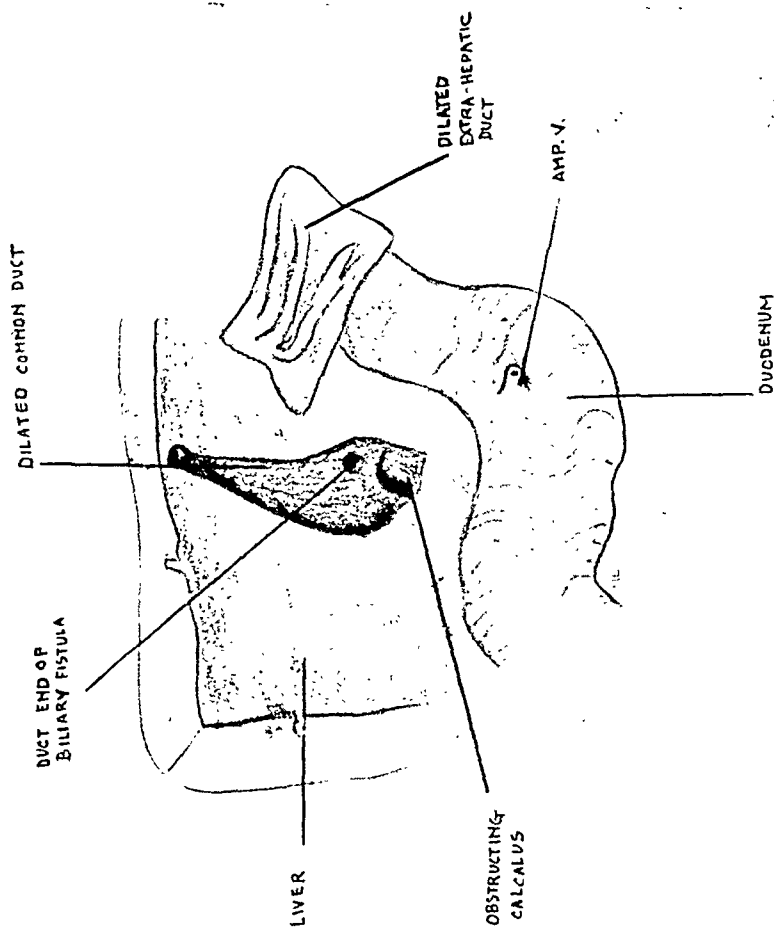


FIG. 4.—Drawing of same patient disclosing obstructing stone in common duct not discoverable at operation and only after a prolonged search post-mortem.

TRANSPLANTATION OF BILIARY FISTULA INTO STOMACH

gall-bladder was absent. The fistulous tract with a plaque of skin was dissected down to the liver and sutured within the antral portion of the stomach through a vertical incision similar to the technic described before this Society, published in the *ANNALS OF SURGERY*, vol. xcv, pp. 263-268. Microscopical examination of tissue removed from about the fistula showed chronic inflammation. He discharged small amount of bile the first few days and ran a temperature of 100 to 105° during the first six days. Thereafter to the twenty-ninth day the temperature ranged from 100 to 102.6°. It became normal on the twenty-ninth and he was discharged to the outpatient department on the thirty-third day. During the last week of hospital residence, the wound healed, and he gained 3 pounds in weight. His appetite improved, the gaseous eructations improved, his bowel movements have become normal so that he had a movement a day without cathartics, and weight has increased to present amount of 155 pounds.

The restoration of bile to the stomach appears to have improved his gastric function and bowel elimination. The seepage of a small amount of bile after these anastomoses is thought to be consistent with the changes going on about the fistulous neck within the grasp of the stomach wound during the first few days. It is believed helpful to keep the stomach empty and at rest during this interval. The arrangement seems to be as normal and still as direct and simple as possible in a poor-risk case after cholecystectomy, with obstructed common duct completely obscured in adhesions.

It is thought that a reparative operation upon the bile-ducts to be safe and permanent should be carried out as in the above technic without an indwelling catheter and should be entirely free from any tension upon the anastomosis. The skin flap admirably serves to fix the tract while healing occurs within the stomach wall. The making of this flap a little larger than the opening in the stomach of itself prevents retraction. In this procedure the adhesions have been taken advantage of inasmuch as they have already arrested the stomach in a position most favorable for bile fistula implantation.

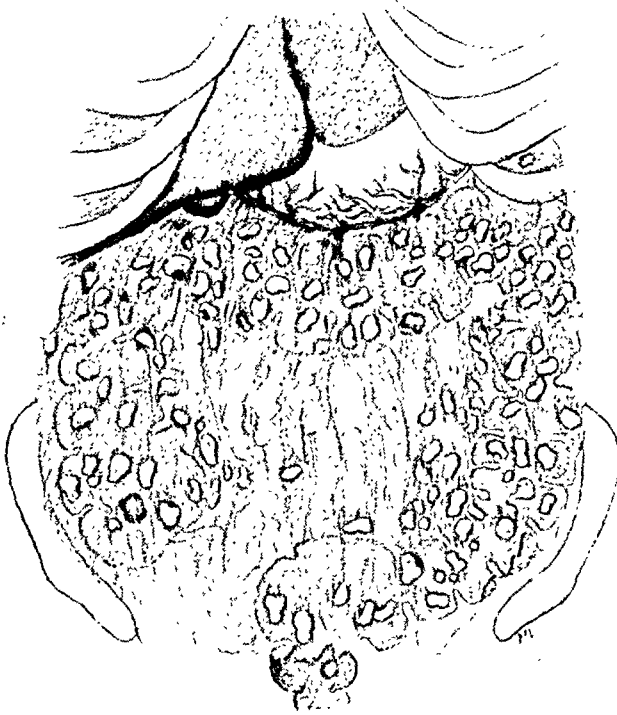
Doctor Barber, in conclusion, declared that given a persistent biliary fistula it was the practice to determine from a study of the history and all procurable data the most probable cause of the duct obstruction. If the condition appears to be due to an incompletely removed gall-bladder with stones and the operable field is not too obscured with adhesions, the indication is clear for cholecystectomy but if the condition is not clearly indicated by the data at hand and the operability of the cause of the obstruction remains in doubt, the fistula is dissected out to the liver border and held in reserve while the ducts are explored. Should exploration be impossible or should the cause of the obstruction be an irremovable growth or stricture, transplantation is carried out and the wound closed about a drain.

He reported a case of the latter type jaundiced notwithstanding complete external fistula with profuse drainage, emaciated, asthenic, prematurely senile, with a leucopenia that did not respond to repeated transfusions, adhesions following two gastroenterostomies and a cholecystectomy making exploration impossible. See Figs. 3 and 4. Transplantation into the oral duodenal loop was attempted, held for two days, but sloughed out apparently because of the extreme lowered resistance and physical reserve of the patient. He showed drawings of this case illustrating a common-duct stone which required one hour's post-mortem dissection to expose, dilated extrahepatic ducts, and a yellow atrophic liver. There had been, perhaps, six of the former category and three of the latter in the past four to five years. Of the latter two both of whom have been shown before this Society were successful and the one illustrated above, hopeless from the beginning, was unimproved.

DIVERTICULOSIS WITH EXTRUSION OF FECOLITHS INTO OMENTA

DOCTOR BARBER presented a woman, forty-one years of age, who was admitted to Bellevue Hospital February 5, 1932. She gave a history of increasing fatigue during her housework since November, 1931. She complained of nausea and vomiting coming on immediately after meals. She had neither hæmatemesis nor tarry stools but had noticed bright blood in her bowel evacuations. There was neither rigidity nor tenderness in the abdomen but the liver descended two fingers below the costal border; spleen was enlarged and ascites present. January 23, 1932, the X-ray department reported numerous diverticula throughout cæcum, ascending and descending

colon. Duodenal cap fixed in region of gall-bladder; normal œsophagus and stomach. Gastric analysis showed low total and absent free hydrochloric. Stool examination showed considerable neutral fat. Urine, negative. The blood showed 3,370,000 red cells; 50 to 60 per cent. hæmoglobin; 8,000 leucocytes and 76 polymorphonuclears. Wassermann, both blood and spinal, negative. Van den Bergh direct, delayed; and indirect, positive. Icteric index plus 9-20. Non-protein nitrogen, 32. Sugar, 110. Creatinin, 1.6. A tentative diagnosis of cholecystitis was made together with cirrhosis and diverticulosis.



Diverticulosis with omental faecoliths.

Based on X-ray and operative findings.

FIG. 5.—Drawing depicting extreme diverticulosis of colon in cirrhotic adult female patient. Many of the diverticula had ruptured setting the concretions free in the omentum. There was total absence of reactionary inflammation at sites of rupture in the colon or at the sites of lodgement in the omental fat. Cf. experimental drawings, Figs. 8 and 9.

hard; gall-bladder was free, slightly thickened but emptied under pressure; there were no stones and no adhesions; pancreas was moderately thickened. There was considerable free sanguinous fluid in the peritoneum. The outstanding finding, however, was the multiple concretions studding the great omentum (Fig. 5) bordering upon the ascending, transverse and descending colon. The concretions were found within the diverticula observed on the röntgenograms. Many of these concretions approximated 3 centimetres in diameter, but most of them 1 centimetre. One was removed from the hepatic flexure region of omentum and one from the sigmoid colon together with the diverticulum. Abdomen was closed without drainage.

The microscopical report dated, February 16, 1932, was as follows:

DIVERTICULOSIS WITH EXTRUSION OF FECOLITHS INTO OMENTA

Specimen consists of two irregular-shaped masses of material, one specimen is about 1 centimetre in diameter, very friable, dark brown in color and resembles a faecolith. On section it cuts with marked ease; shows a dark brown centre with a lighter brown periphery. The second piece is grayish on section. Microscopically the tissue (Fig. 6) is that from the large intestine with round-cell infiltration and small connective-tissue deposit. The faecolith (Fig. 7) shows the usual structureless material with golden yellow bile pigment and nondescript material.

The woman has since returned for treatment of cardiac decompensation. The abdominal condition has remained practically symptomless.

The interesting feature in this case is the occurrence of repeated slow perforations of diverticula by faecoliths without the production of symptoms of diverticulitis and without observable inflammatory reaction in the omental fat or adjacent borders of colon. Apparently, the colonic wall overlying the faecolith thinned out and gave way as the neck of the diverticulum closed in, thus allowing the escape of calcified faecoliths without contamination from the bowel.

An attempt was made to reproduce experimentally the passage of foreign



FIG. 6.—Low-power microphotograph of wall of diverticulum from the colon. Note the thin muscular coat.

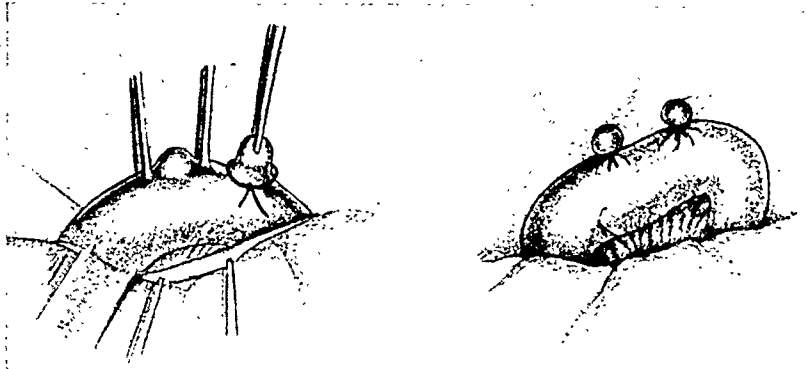


FIG. 7.—Low-power microphotograph of a section through a faecolith taken from the omentum.

bodies from diverticula-like pouches of sigmoidal wall, and is represented on accompanying drawings. Four glass beads (Figs. 8 and 9) 1 centimetre in diameter, were drawn out from within the wall of the bowel, two at the mesosigmoidal border and two at the antimesenteric border, and ligated with linen as shown in illustrations. Omentum was sutured about the segment containing the beads. Nine days later the beads had perforated the bowel, one suture had invaginated and remained attached at margin of healed perforation, the remaining three had evaginated and were found buried in nodules of dense fibrous tissue; and small intestine and urinary bladder, in addition to omentum, were firmly adherent at sites of perforation. There was no evidence of peritonitis. The dog was in good condition when submitted to euthanasia.

The similarity in the clinical and experimental findings is that perforation proceeded without peritonitis but the striking difference is the absence of inflammatory reactions after several perforations in the clinical case and the marked fibrous tissue production in and about the experimental perforations.

Drawings representing technic of ligating beads in diverticula-like pouches in canine colon.



Omentum sutured over "diverticula."

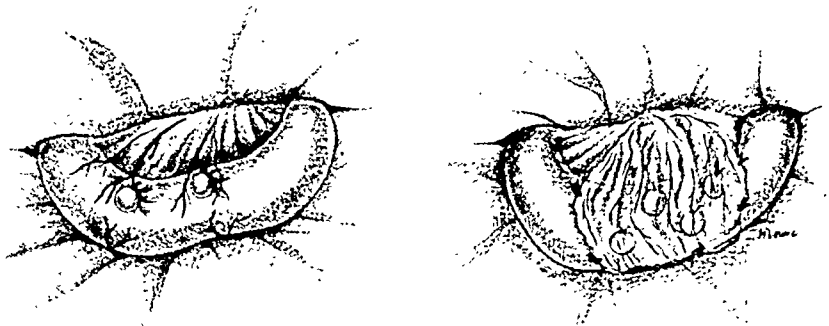
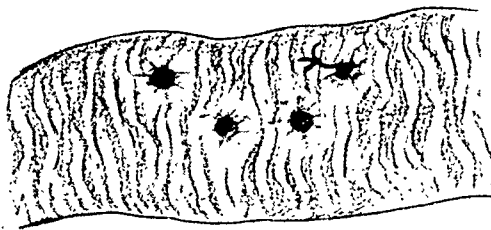


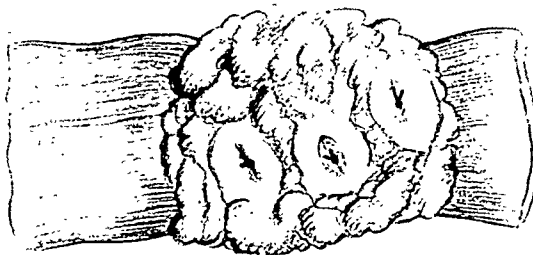
FIG. 8.

Mucosal surface of colon nine days later. Note healed perforations.



SIGMOID SHOWING HEALED PERFORATIONS WITH ONE SUTURE IN LUMEN.

Serosal surface with attached omentum. Note nodules of dense fibrous tissue about sites of rupture of foreign bodies. Cf. Fig. 5.



SIGMOID SHOWING SEROSAL SURFACE WITH ADHERENT OMENTUM, SMALL INTESTINE AND BLADDER.

3 SUTURES APPEAR WITHIN NODULES OF FIRM FIBROUS TISSUE.

FIG. 9.

COMMINUTED SPIRAL FRACTURE OF FEMUR WITH OPEN REDUCTION

This latter observation is believed to be more in keeping with clinical experience.

DR. CARL EGGERS said that in diverticulosis of the colon some of the patients present an alarming clinical picture, with symptoms of intestinal obstruction, but half of them will recover without surgical interference. The majority who come in for surgery come for an acute emergency. All patients who have diverticulosis are liable to develop diverticulitis with its high mortality. Therefore they should be advised to keep the bowels open and adhere to a light diet with little residue. The disease should be looked upon as a serious condition.

COMMINUTED SPIRAL FRACTURE OF THE FEMUR WITH OPEN REDUCTION

DR. DONALD GORDON presented a woman, thirty-seven years of age, who while walking on the street on April 10, 1929, was struck by a motor car. She was taken to a nearby hospital where X-ray showed comminuted fracture of middle third of left femur with displacement, and a reduced fracture of right ankle. There were multiple contusions of face. The patient's employer had her transferred to the Fifth Avenue Hospital, where an immediate X-ray showed the left femur to have a comminuted spiral fracture of the shaft just below the middle, with one fairly large detached fragment from the inner and posterior portion of the shaft. There was very slight overriding and the alignment was fair. The right ankle showed a Pott's fracture with posterior dislocation of tarsus, a fragment off posterior surface of the inferior articular surface of tibia.

April 11, 1929, under general anæsthesia, the fracture of the right ankle was reduced with the patient in bed, and a non-padded split plaster encasement was applied from toes to mid-thigh. Röntgenogram of right ankle after reduction showed fragments in good position. The left femur showed greater displacement, proximal fragment more internal and distal fragment more external. Four days of skin traction with 30 pounds showed no improvement in position of the femoral fragments. The fracture was manipulated under general anæsthetic. No crepitus could be felt. It was then considered that muscle was interposed between the fragments, which were held apart by the third fragment. Under general anæsthesia again axis traction tongs were applied to the left femoral condyles and strong traction made with manipulation of fragments in an endeavor to obtain reduction without open operation. The leg was put in a Thomas splint with the leg in full extension, and about 20 pounds weight applied to tongs. Three days later a röntgenogram showed the tongs in position on the shaft of the femur about 4 inches above the articular surface of the knee. The overriding was corrected. There was some lateral displacement of the lower fragment, and slight anterior bowing. It was then decided to resort to an open replacement, using the Parnham bands to hold the ends of the fragments together and to use the axis traction tongs, which would permit the leg to be fully extended, together with a Thomas splint for external support. The patient was taken to the operating room in a Thomas hip splint with traction maintained on the tongs. Under general anæsthesia the Thomas splint was removed while traction was maintained on the tongs by an assistant; the fracture was exposed by lateral incision 20 centimetres in length. Interposed muscle fibres were displaced from between the fragments. Contact was apparently normal between the

proximal and distal fragments. The ends of these fragments were placed in contact, and held by two Parnham bands. The middle third fragment was not disturbed with the purpose of avoiding injury to its blood supply and avoiding infection by its proximity to the tongs. The wound was closed and the Thomas splint reapplied. No other support was applied for external fixation other than the Thomas splint with the skeletal traction.

At the end of ten weeks, July 2, 1929, the Thomas splint was removed. Fair union in the femur had taken place. She could raise her limb off bed, and had 15 degrees voluntary knee motion.

August 12, she was discharged from the hospital with a walking splint on left limb made with knee- and ankle-joint to allow motion at these joints and extending up thigh to tuber ischii. Both legs $32\frac{1}{2}$ inches, left knee flexion 50 degrees, hip motion satisfactory. Right ankle in good condition.

This case illustrates a comminuted spiral fracture of the femur which neither skin nor skeletal traction afforded reduction by reason of the interposition of muscle fibres, the intrusion of which was favored by the presence of a complicating third fragment kept the proximal and distal fragments separated. Secondly, the use of a new type of skeletal traction tongs which permits the leg to be fully extended on the thigh. These tongs also have non-penetrating grip, and are prevented from graving out by the broad surface exposed to the cortex of the bone when the points are driven into the bone. The reporter had used these tongs to maintain extension of the leg and avoid the torsional strain which a long lever like the flexed leg might exert on the insecure internal fixation afforded by two Parnham bands as applied in this specific case.

ACUTE SUPPURATIVE ARTHRITIS OF KNEE-JOINT

DR. GORDON presented a child, aged six years and ten months, who was admitted to the Fifth Avenue Hospital May 17, 1928, with infection of the left knee-joint.

Four days before admission the boy had run a rusty nail into his left knee. He developed a temperature following this with increasing pain and swelling, with a complete loss of function of knee. The child has been in very good health. Fifteen hundred units of tetanus antitoxin were given in clinic. Temperature 101.8° ; pulse 90, respirations 24. The left knee-joint was swollen, and contained fluid. There was tenderness on pressure over inner side of medial condyle of femur.

The joint was aspirated and 5 cubic centimetres yellow purulent material withdrawn from knee-joint, which on culture showed staphylococcus albus.

Operation.—Under ether anæsthesia an 8-centimetre incision was made on each side of the patella down to the synovial membrane. The joint was opened into, exposing cul de sac above and interarticular space below. There was a watery, grayish-like pus filling the joint under no great tension. The synovial membrane was œdematous and red, very much congested and swollen. The cartilage was red with deeper red punctate spots. There was no normal-appearing white cartilage seen. The joint was washed out with normal saline solution, and rubber dam strips were laid over edges of incision down to synovial membrane with loose gauze on top. Dry gauze was placed about this, a sterile cotton roll and a compression bandage of gauze were applied. Skin traction was applied to the leg, and the limb elevated in a half ring Thomas splint, three pounds traction weight applied.

Orders for the first night were: (1) Dakin's solution q. 2 h.; (2) voluntary movements of few degrees q. 2 h. under supervision of nurse; (3) trac-

TRANSCERVICAL FRACTURE OF NECK OF FEMUR

tion to be continuous; (4) elevation of leg above heart. In the evening after operation, the temperature rose to 102° , then fell to 100° . The wound was dressed on the following day, gauze only removed, and a Carrel tube covered with gauze was laid in each incision between the rubber strips, but not into joint, and surface irrigated with Dakin's solution q. 2 h. Dressed daily thereafter.

On the twenty-second wound was examined. There was little discharge, wounds clean and doing well. Child moving knee voluntarily q. 2-3 h. up to 20° without pain. The next day the temperature rose to 101.6° .

On the twenty-third, grayish membrane on surface of soft parts in wound. Treated with 5 per cent. silver nitrate.

On the twenty-seventh, knee doing well. No drainage, and temperature normal. Resisted extension movements of leg instituted. Steady improvement thereafter.

January 21, his wound had healed without crust; he was walking with slight limp. Discharged the next day with 90 degrees flexion. He had been walking for a week.

At follow-up three months later, family stated he returned to school two weeks after leaving the hospital. He had slight tenderness of scar, freely moving patella, and no limitation of motion in knee-joint.

This case illustrated the importance and value of early drainage of an acute suppurative arthritis of the knee-joint, due to an implantation infection, before the articular cartilages have become infected to such a degree that their viability has become destroyed.

TRANSCERVICAL FRACTURE OF NECK OF FEMUR WITH OLD MID-THIGH AMPUTATION

DOCTOR GORDON presented a man, forty-two years of age, who was admitted to the Fifth Avenue Hospital January 14, 1932, with a fracture of neck of left femur, with old mid-thigh amputation.

During the war, the patient received an injury to left leg which required amputation of limb just about junction of middle and lower third of thigh. He had worn an artificial limb since. On the evening before admission while walking on the street, he stepped on something slippery and fell with the left leg doubled up under him. He was taken home on account of pain in hip and stiffness of the joint. He was brought to hospital the following day.

X-ray films of both hips show a fracture through the neck of the left femur very near the head. There is a slight deformity but the fragments are in good contact, and the appearance is that of some impaction.

Under gas-oxygen and ether, the leg was abducted and put in hyper-extension. Internal rotation could not be secured because of the absence of the knee and foot. A modified Whitman spica was applied from high on chest to beyond end of stump on left side. No attempt was made to break up any impaction.

Two weeks later the bandage above right groin was cut away to permit him to sit in a chair. He was up walking on crutches, with which he was familiar, and was discharged to his home to return to the hospital in ten weeks for removal.

March 27, 1930, ten weeks following application of the bandage, he returned for its removal, which was done. Had movement of 45 degrees flexion, extension about 15 degrees, abduction and adduction good without pain. X-ray films of hip showed the fragments in the same position as in previous examination. There is apparently some callus production.

Six months after fracture, he stated at a follow-up, that five weeks after leaving the hospital he began to walk using artificial leg, with crutches; at five months began weight bearing and walking with crutches. Still uses cane. Can sit in chair naturally. Can abduct left leg 30 degrees, flex thigh 90 degrees.

This case demonstrates the adequacy of repair in a high cervical fracture of the femur with some impaction in a relatively young person, using the Whitman abduction principles in so far as they could be applied, in the absence of the knee and foot to control internal rotation.

GASTROJEJUNAL ULCER AFTER GASTROENTEROSTOMY

DR. J. WILLIAM HINTON presented three cases of gastrojejunal ulcer occurring after gastroenterostomy.

GIANT-CELL SARCOMA OF TIBIA

DR. WILLIAM B. COLEY presented a woman who at the age of twenty-three years was admitted to the Hospital for Ruptured and Crippled in October, 1904, on account of a large, soft swelling over the internal malleolus of one tibia. At operation much reddish-brown, soft material was removed from the lower end of the tibia. The entire lower third of the tibia was apparently involved, and only a thin outer shell remained. The ankle-joint was not involved. Microscopical examination gave the diagnosis as giant-cell sarcoma.

A local recurrence developed and on January 3, 1905, a second curettement was performed followed by prophylactic treatment with toxins and Röntgen-ray. At the time of her discharge from the hospital, five months later, regeneration of bone had taken place in the destroyed area of the lower end of the tibia, and there was a perfect functional result.

At the present time, twenty-eight years later, the patient remains in good condition with no evidence of a recurrence.

A second case presented was a woman who when seventeen years old was admitted to the Hospital for Ruptured and Crippled in August, 1913. An extensive curettement was done followed by tight packing. The wound healed and the cavity filled up without infection. A few days later the toxin treatment was begun, but on account of a severe attack of "grippe" it was discontinued in January. A short while later a recurrent tumor was found at the upper and inner end of the right tibia, at the side of the old sinus. A second curettement was performed. This was followed by a prompt recurrence. One application of the radium pack (12,000 millicurie hours) was given over the site of the tumor, and the toxins were resumed and kept up for a number of months. The patient made a complete recovery and is in excellent health at the present time, seventeen years later.

In this case Doctor Ewing's original diagnosis was that of typical giant-cell sarcoma of the epulis type and of very moderate malignancy. A microscopical section was submitted to Dr. George Barrie, who had made a special study of benign giant-cell tumors, and he reported the condition to be a malignant one. With this opinion Doctor MacCarty of The Mayo Clinic agreed. However, the Bone Sarcoma Registry (see case No. 145) has classified the case as a benign giant-cell tumor.

Doctor Coley said he had presented these two patients because he believed that the problem of the treatment of benign giant-cell sarcoma of the long bones was a most important one, and that there was no unanimity of

EMBRYONAL CARCINOMA OF TESTIS

opinion among surgeons as to what method of treatment should be employed in an individual case. Paget and Nêlaton, more than eighty years ago, pointed out the benign nature of the majority of giant-cell tumors and advocated conservative measures, their teaching had little permanent influence; up to comparatively recent times amputation remained the method of choice in the great majority of cases.

Doctor Coley believed he had the honor of being the first to advocate the conservative treatment of sarcoma of the long bones exclusive of giant-cell tumors.

Doctor Coley showed lantern slides of two other cases of very extensive giant-cell sarcoma of the femur with involvement of the knee-joint, and of the tibia as well in one case, in which recovery took place, under toxins alone in one case, and under toxins and curettage in the other. In the latter, one radium pack (12,000 millicurie hours) was applied and a steel needle containing 100 milligrams radium was introduced into a small sinus and left there for three hours. This, however, Doctor Coley believes was entirely unnecessary as the patient was apparently cured when the irradiation was begun. A noteworthy feature of this case was the short period of disability, *viz.*, only four months. There was almost complete restoration of function, and the patient remained in good health until eight years later when she died of hæmorrhages from childbirth. Doctor Coley could recall no case in literature of a giant-cell sarcoma of the lower end of the femur with extensive knee-joint involvement that had been cured by anything short of amputation.

EMBRYONAL CARCINOMA OF TESTIS

DR. BRADLEY L. COLEY presented a man, forty years of age, who was first seen April 16, 1928, when he was admitted to the Hospital for Ruptured and Crippled with a history of having had a painless enlargement of the right testis of five years' duration. It had grown slowly at first but during the past year he felt its increase had been more rapid.

The right half of the scrotum was enlarged to the size of a small grapefruit by a semi-cystic swelling, which was tense and which transilluminated. The testis could not be made out by palpation of the mass. April 17 he was operated upon under ethylene anæsthesia through a scrotal incision. Upon opening the tunica vaginalis the escape of several ounces of bloody fluid revealed an obviously malignant tumor which had replaced the testis. An inguinal incision was then made and the vessels of the cord and vas deferens were clamped high up at the internal ring and the entire mass removed *en bloc*.

The pathological report was embryonal carcinoma of the testis with lymphoid stroma, Grade IV, radiosensitive; it belongs to the type known as seminoma of Chevassu.

The *post-operative treatment* consisted in 152,000 milligram hours of exposure to the radium element pack, using a 6-centimetre portal at 15-centimetre distance; four portals—right abdomen anteriorly, posteriorly, right groin and right scrotum. These treatments were given over a period of five weeks, requiring thirty-eight hours of actual exposure, and were followed seven weeks later by two high-voltage X-ray treatments, one over the right

abdomen anteriorly and one posteriorly. The radium and X-ray treatments were given at Memorial Hospital.

During this seven weeks' interval he was re-admitted to the Hospital for Ruptured and Crippled and given a short, but intensive, course of eleven injections of mixed toxins, ten of which were given intravenously, and seven of which produced pronounced rigors and febrile reactions.

Since July 27, 1928, the date of the last X-ray treatment, he has had no treatment whatsoever and has worked steadily as an investigator for the Department of Education. His weight has remained at or above his previous normal and he has been without symptoms.

OSTEOSARCOMA OF FEMUR

DR. WILLIAM B. COLEY presented a tumor of the lower end of the femur, which he believed furnished convincing evidence that there are certain benign giant-cell tumors which become transformed into the malignant osteogenic type. The case under discussion occurred in a male, aged twenty-seven years, who was admitted to the Memorial Hospital in June, 1929, with a tumor of the lower end of the femur which had all the clinical and röntgenological features of a benign giant-cell tumor. Röntgen therapy was given for nearly two years under the direction of Doctor Herendeen. The tumor steadily increased in size, and in 1930 a pathological fracture occurred. After a prolonged period of disability, Doctor Coley, in 1931, advised an amputation. To this the patient would not consent. In October, 1931, he consulted Dr. F. H. Albee who believed it would possible to save the limb by conservative operation, that is, curettage with implantation of fat graft. The operation was performed October 21, 1931; the wound healed by primary union, and the patient left the hospital in good condition. Within one month he developed a daily temperature of 102–103°. He returned to the New York Post-Graduate Hospital, where an amputation was performed January 14, 1932. A very large tumor was found to have developed at the site of the curettage, which had involved and completely destroyed the knee-joint. Microscopical examination showed an entirely different type of tumor from the one removed in October, 1931. It was a definitely malignant osteogenic sarcoma with no trace of giant-cell structure. A few weeks later another operation had to be performed for a recurrence in the stump. Röntgenograms taken at this time showed definite evidence of pulmonary metastases. The patient died on April 1, 1932.

FREE FULL-THICKNESS SKIN GRAFT. ITS FIELD OF APPLICABILITY AND TECHNICAL CONSIDERATIONS

DR. JOHN GARLOCK read a paper with the above title for which see page 259. The reading of the paper was accompanied with a motion picture demonstration.

DR. WILLIAM F. MACFEE said there is no question but that the full-thickness graft resembles normal skin more closely than the Thiersch. Its limitations, however, are numerous. It may be used only in clean wounds. Another point is that when one gets a take small areas of necrosis are likely to develop and those little sloughing areas are slow to heal. They are likely to become infected and show a tendency to form keloids. For any place about the face this is a serious disadvantage. The tendency of full-thickness

GASTRIC RESECTION WITH INTESTINAL OBSTRUCTION

grafts to become pigmented is important when considered for use about the face.

There is one thing about full-thickness grafts which Doctor Garlock did not mention and that is if buried beneath other tissues the full-thickness graft will nearly always take. The epithelial surface probably derives some nourishment from the overlying raw surface as well as from the raw surface beneath. This vitality of the buried graft is important in the use of pedicle flaps about the face. It is often desirable to have both sides of the pedicle graft covered by skin. By burying the full-thickness graft under the flap one will nearly always get a complete take.

STATED MEETING HELD OCTOBER 12, 1932

The President, DR. JOHN DOUGLAS, in the Chair

GASTRIC RESECTION WITH INTESTINAL OBSTRUCTION FORTY-EIGHT HOURS LATER

DR. J. WILLIAM HINTON presented a man, aged thirty-six years, operated upon at Post-Graduate Hospital June 20, 1932, for a duodenal ulcer with chronic pancreatitis. For ten years previous to admission to the hospital the man had had attacks of epigastric pain, coming on three or four hours after meals; the discomfort was relieved by the intake of food. At the beginning of his trouble he had periodicity with intervals of six to eight months in which he would be free from discomfort. His symptoms had gradually increased in severity and for the past two years he has been under constant medical treatment for an ulcer of the first portion of the duodenum. X-rays taken May 2, 1930, had revealed a duodenal ulcer. In spite of a Sippy régime, Saunder's vaccine intravenously, and gastric mucin, this patient did not obtain symptomatic relief. X-rays November 5, 1930, July, 1931, and April, 1932, had all confirmed the duodenal ulcer. At the time of admission the patient was suffering constant pain in the epigastric region which radiated through to the small of the back.

Operation June 20, 1932, revealed a large duodenal ulcer on the posterior portion of the duodenum which was adherent to the pancreas. The head of the pancreas was enlarged and showed evidence of chronic inflammation with a normal gall-bladder. In view of the pancreatitis a gastric resection was done with an anticollic anastomosis and an enteroenterostomy. After completing the operation the omentum, which was quite heavy, was placed over the suture line, and the abdomen closed. A Levine tube was placed in the stomach. The patient made an uneventful convalescence until forty-eight hours later when it was noticed on irrigating the stomach that there was a definite fecal color to the stomach contents. The patient had no complaints and was in excellent condition, except his pulse had gone from 90 to 130. A diagnosis of high intestinal obstruction was made and the patient observed for another two hours to be sure that the obstruction was complete. At the end of this time a second laparotomy was done. The abdomen was opened through a left rectus muscle-splitting incision and on opening the peritoneum and inspecting the anastomosis between the stomach and the jejunum, and the enteroenterostomy, it was found that the omentum had slid to the left above the transverse colon and in so doing caused a torsion

of the efferent loop of the jejunum, producing a complete obstruction. The omentum was then replaced in its normal position and the abdomen closed.

There was considerable fecal drainage through the Levine tube for the next six hours but after that the irrigations became clear and the patient had an uneventful convalescence.

DR. EDWIN BEER said it was surprising that after extensive gastric operations, and even after gastroenterostomies, that intestinal obstruction due to adhesions to the raw surfaces adjacent to the suture line was not more frequent. Years ago, the patient, after gastric operation, such as gastroenterostomy, frequently had what was called a vicious circle. In those days, extensive gauze protective packs were used during the operation and probably this gauze frequently led to post-operative adhesions about the anastomosis and to ileus caused by the adjacent small intestinal loops becoming plastered onto the anastomosis. In looking over his records, he found two such cases following gastrojejunal anastomoses. Having seen various surgeons make anastomoses between jejunum and stomach in various positions and with various clamps, *etc.*, it is more than likely that the method of anastomosis was not the cause of the so-called vicious circle, as much as secondary adhesions leading to high intestinal obstruction which would produce symptoms suggestive of a vicious circle. The only method of treatment is immediate re-operation, as patients go downhill very rapidly.

GASTROJEJUNAL ULCER WITH CHRONIC PANCREATITIS. RESECTION OF JEJUNUM

DR. J. WILLIAM HINTON presented a man, aged forty-one years, who was admitted to the Stomach Clinic of the Fourth Medical and Surgical Divisions of Bellevue Hospital December, 1930, complaining of pain in his back and epigastrium for the past ten years. The patient stated he had been operated upon in the Jersey City Hospital on April 7, 1926, and the report from that institution revealed from X-ray study on March 22, 1926, ptosis of the stomach with an irregular duodenum and ptosis of the transverse colon. At operation April 7, 1926, the stomach, gall-bladder and duodenum were found normal. The appendix was chronically diseased and an appendectomy done. He was not relieved of symptoms following the operation and one year later he was having more distress than before the operation. X-rays taken in April, 1927, revealed a duodenal ulcer. He was treated for this but on March 14, 1930, he had a sudden severe abdominal pain and was taken immediately to the Jewish Hospital in Brooklyn and operated upon for a perforated ulcer. Operative findings in that institution revealed an old indurated pyloric ulcer on the posterior surface perforating into the pancreas. A closure of the perforation was done with a posterior gastroenterostomy.

Following the operation he received relief from his symptoms for only about two months. Since then he has had constant discomfort until coming under the reporter's observation in December, 1930. X-rays taken December 29, 1930, revealed a persistent deformity of the first portion of the duodenum, characteristic of a duodenal ulcer, with a gastroenterostomy of somewhat diminished function but no jejunal ulcer demonstrated. From that date until October 22, 1931, he was receiving Saunder's vaccine intravenously, gastric mucin and a Sippy régime, but in spite of this he got no relief from his

GASTROJEJUNAL ULCER WITH CHRONIC PANCREATITIS

symptoms. X-rays taken in August, 1931, revealed a duodenal deformity characteristic of an ulcer with a normal gastroenterostomy stoma. He then discontinued treatment in the clinic and was under the care of private physicians until September 1, 1932, when he returned complaining of severe abdominal pain which necessitated his having morphine at intervals for several weeks for the relief of his pain. In view of his excruciating pain a diagnosis of jejunal ulcer penetrating into the pancreas, with chronic pancreatitis, was made.

Operation September 9, 1932. On opening the peritoneal cavity numerous adhesions were found, but on inspecting the pylorus and duodenum no evidence of ulceration could be detected, but there was a large penetrating gastrojejunal ulcer on the jejunal side into the pancreas. The stoma was disassociated and the stomach closed, and eight inches of the jejunum resected with an end-to-end anastomosis. The patient made an uneventful convalescence and was discharged fifteen days later.

This patient was presented to illustrate the difficulty in diagnosing marginal ulcers in spite of repeated gastro-intestinal X-ray series. Marginal ulcers are frequently overlooked and one should not rely too much on X-ray studies in reporting cures following gastroenterostomies.

DOCTOR HINTON presented three cases for the purpose of drawing attention to gastric symptoms being produced by a thyroid deficiency; as there is no evidence of a goitre in these patients the diagnosis is frequently overlooked, and patients of this type are operated upon with unsatisfactory results.

CASE I.—Woman, graduate nurse, twenty-eight years of age, first seen in August, 1931, complaining of nausea and vomiting with pain in epigastrium for the past ten years. Her condition is usually worse in the late afternoon, or around 10 to 12 at night. Her past history was negative, but in 1920, at the age of eighteen, she was X-rayed at the Boston City Hospital for a duodenal ulcer and the X-rays were reported as being suspicious. She had followed an ulcer régime for several years, without relief of her symptoms. Before consulting the reporter she had had two gastro-intestinal X-ray series taken at Bellevue Hospital which were reported negative. She stated that she vomited undigested food. Her skin was dry, hair was falling out and she tired easily, and had very little energy until the middle of the day; her symptoms were made worse after a day's work. Physical examination revealed epigastric tenderness with pulse 64, blood-pressure of 100 over 70; a diagnosis of hypothyroidism was made. A basal metabolism done August 28 was a minus 18. The patient was not put on treatment until October 10, 1931, as she left town after the examination. Then she was given thyroxine .60 grain, intravenously, and thyroid extract grains I, T. I. D., by mouth. She was given eight injections of thyroxine, intravenously, at weekly intervals, after which she was greatly improved. November 27, 1931, her basal metabolism was a minus 8, and she was practically free from symptoms, and was not seen again until January 30, 1932. At that time she stated she had been well since her last visit, bothered with nausea only a few times, her hair was greatly improved, and her basal metabolism repeated at that time was a plus 3, but she continued taking thyroid extract daily. March 16, 1932, she was weighing 149 pounds, a gain of ten pounds while under treatment. At this time the patient is about fifteen pounds heavier

than when treatment was started and with the exception of a tired feeling when medication is discontinued she has no complaints.

CASE II.—Male, fifty-nine years of age, seen July 15, 1932, complaining of loss of fifty pounds in weight, vomiting and weakness. *Past History*.—Negative. *Present Illness*.—The patient states that three years ago he began having attacks of nausea and vomiting with some epigastric distress. Attacks have gradually gotten worse and during the past six months he has not worked. Has vomited large quantities of thin watery secretion. Physical examination revealed epigastric tenderness and suspicion of mass in right upper quadrant. Gastro-intestinal series ordered with a diagnosis of carcinoma of the pylorus, but the X-rays were reported negative. The patient had no symptoms referable to a thyroid deficiency but a basal metabolism was ordered as a means of ruling out a hypothyroidism. The first test was unsatisfactory, and on August 4, 1932, his test revealed a minus 22. He was put on thyroxine intravenously, at weekly intervals, and thyroid extract grains I, T. I. D. and since treatment was started he has been free from symptoms and feels perfectly well and has gained about seven pounds in weight. A basal metabolism done on September 28 was a plus 13. Thyroxine has been discontinued and he is now taking thyroid extract by mouth.

CASE III.—Male, aged sixty-two years, first seen in March, 1932, complaining of nausea and vomiting and a burning sensation in upper abdomen which was relieved by the intake of food. *Past History*.—Negative. *Present Illness*.—Patient states he has had a burning sensation in abdomen for the past four years and that this has been gradually getting worse and for the past several months he has had constant abdominal discomfort with nausea and vomiting which has incapacitated him from work and during this time he has lost fifteen pounds. A gastro-intestinal series done at Bellevue Hospital was negative for a gastric or duodenal ulcer but a basal metabolism done March 18 revealed a minus 19. The patient was then put on thyroxine intravenously, at weekly intervals, and thyroid extract grains I, T. I. D. He began to show improvement and for the past four months has been symptom-free. To date he has had seventeen injections of thyroxine, and has continued thyroid extract by mouth. Basal metabolism done on October 5 was a plus 23. At this time he weighs 118½ pounds, as against 104 pounds when treatment was started. Thyroxine has been discontinued and he is taking only two grains of thyroid extract daily.

These patients will have to continue thyroid medication but after the basal metabolism has been raised to normal with thyroxine, intravenously, it is much easier for them to be kept in balance by oral administration. Patients suffering from hypothyroidism frequently do not absorb thyroid satisfactorily when administered orally and that is the reason for using thyroxine intravenously.

JEJUNOSTOMY FOR GASTRIC ULCER

DR. HUGH AUCHINCLOSS presented a man, forty-four years of age, first seen by him December 21, 1931. He came for relief of long-standing indigestion. He did not appear seriously ill. His brother had a gastric ulcer and his mother died of carcinoma. In 1922, he began to have digestive symptoms, and this year his gall-bladder and appendix were removed at Lebanon Hospital. In 1924, his symptoms returned. At various times under gastric lavage, milk, cereal, toast and simple diet, he had been greatly relieved. About June, 1930, his symptoms began to be more persistent. He was unable

PAGET'S DISEASE OF BONE MISTAKEN FOR METASTATIC CARCINOMA

to work because of a pain that came on irregularly, not only before, but after meals, beginning in his left lower chest, chiefly in his epigastrium, and radiating to the lower abdomen, ending up low down in his back. The pain was very severe. It was not relieved by taking food, but when on a careful diet he had less of it. He was chronically constipated and had gaseous eructations, nausea, and occasional vomiting.

In 1930, X-ray studies at the Presbyterian Hospital showed a small gastric residue, but no other evidence of pathology in the gastro-intestinal tract. Just previous to admission in December, 1931, a crater of considerable size was demonstrated on the lesser curvature, indicative of ulcer of the stomach.

December 30, 1931, a partial gastrectomy and a post-colic gastroenterostomy with a jejunoduodenostomy and a jejunostomy were done. At the end of a rather long operation his blood-pressure was 120 and his condition good. A Murphy button was used in doing the jejunoduodenostomy. The button was passed the twenty-seventh day after operation.

Sterile 5 per cent. glucose was given to him through the jejunostomy opening for two weeks. At first the tube was left unclamped but later was clamped for varying periods of time. Up to 1,200 cubic centimetres of fluid a day were taken in this way. His stomach was washed three times during the first week because of hicough. Incidental to this there was a separation of the wound edges without visceral protrusion. Although this prolonged his stay in bed it was not of particular significance. This has, however, given rise to a post-operative hernia.

PAGET'S DISEASE OF BONE MISTAKEN FOR METASTATIC CARCINOMA

DR. MORRIS K. SMITH presented a man of sixty-one years who entered St. Luke's Hospital in January, 1930, in care of Dr. H. G. Bugbee, for hypertrophied prostate. Fifteen days after a first-stage suprapubic cystostomy, while he was being helped into a chair, his left thigh snapped. X-ray examination showed a pathological fracture of the left femur with bone changes, as later determined, also in the pelvis, sixth dorsal vertebra, and right humerus, thought to be those of metastatic carcinoma. The skull was not involved. Although the prostate did not suggest malignancy to palpation it was assumed to be the focus and the advisability of going through with the second stage of the operation was questioned. Meanwhile, the fracture was put up in suspension and traction. In two months union was sufficiently firm to allow the patient up in a chair. A month later the prostate was removed by Doctor Bugbee. The pathological report was adenomatous hyperplasia with no evidence of malignancy. The patient left the hospital in May, four months after admission, cured of his prostatic disease and walking with a brace.

Despite the proved innocent character of the prostatic enlargement the fear that he was suffering from malignancy involving the bones still persisted at the time of his discharge. The further progress of his case, however, has ruled this out, and established the diagnosis of osteitis deformans. In the period of two and one-half years since leaving hospital the patient has gained weight and remained well. There is no shortening of the leg and he walks without a limp. A recent X-ray showed the appearance of the involved bones to be approximately the same.

This case was presented to emphasize the difficulty that may arise in the differentiation of Paget's disease and metastatic carcinoma of bone. The reporter referred to an article by Carman and Carrick of The Mayo Clinic

(Collected Papers, vol. xii, p. 1160, 1920), in which they cite fifteen cases of Paget's disease, four of whom were diagnosed by X-ray as metastasis in bone. They state that "the osteoplastic type of metastasis is the one condition that may easily be mistaken from the X-ray standpoint for an osteitis deformans."

When a typical case of Paget's presents, with skull and long bone involvement, the diagnosis is simple, based upon the clinical picture and the X-ray findings, but when the disease is limited to one bone, the diagnosis may be almost impossible. In the X-rays shown by Doctor Smith, the eburnation of the body of the vertebra is more suggestive of carcinoma, whereas pictures of the pelvis and long bones seem more suggestive of Paget's disease; possibly both are combined in this particular patient.

DR. HOWARD LILIENTHAL said that he thought the clinical course had considerable significance in the diagnosis. This man is walking about, perfectly well, the picture of health, so that it does not seem there can be any question of the correctness of Doctor Smith's diagnosis.

DOCTOR SMITH, in closing the discussion, replied to Doctor Bancroft that he had examined the patient's neck carefully more than once hoping to find evidence of an enlarged parathyroid gland but with negative result. A calcium determination made on the serum was 13 milligrams, phosphorus 3.4 milligrams. The calcium output in one twenty-four-hour urine specimen was 360 milligrams.

CYSTS OF EXTERNAL SEMILUNAR CARTILAGE

DOCTOR SMITH presented a man, thirty-seven years old, on whom he had operated for cystic tumor of the external semilunar cartilage in May, 1925. A swelling had appeared on the outer side of the right knee four years before. There was no history of trauma. For the past year there had been pain and disability. Examination revealed a swelling on the outer side of the knee one and one-half inches in diameter. Flexion of the knee was limited to 90°. The thigh on the involved side measured one inch less than its fellow. At operation the tumor was found to be tensely compressed beneath the fascia and attached to the external cartilage of the joint. In cutting it away a yellowish discoloration of tissue was noted similar to that found in the tumor itself, suggesting that the disease may have extended into the cartilage. The cartilage was not removed. On section the tumor was made up of multiple cysts with gelatinous content.

The patient was relieved of his symptoms following the operation and was presented before this Society five months later at the meeting of October 14, 1925. There had not been an opportunity to examine him previous to the presentation, although he had reported himself well. He had at this time a recurrence of tumor at the original site in spite of his symptomatic and functional recovery.

On examination at the follow-up clinic ten months after operation it was found that the tumor was larger than ever before. Although he had no complaints the operation was considered a failure.

Seventeen months after the operation the tumor had decreased markedly

TECHNIC OF JEJUNOSTOMY

in size. At two years a small cystic mass the size of a finger nail remained and at two and one-half years a small mass was still found.

At the next examination three and one-half years subsequent to operation it had disappeared, and at the last examination in December, 1931, six and one-half years after operation, was still absent.

Instances of recurrence necessitating a second operation when the cartilage was not removed at the original intervention have been reported.

JEJUNOSTOMY—A CLINICAL AND EXPERIMENTAL STUDY OF THE TECHNIC

DR. WILLIAM HOWARD BARBER read a paper with the above title for which see page 553.

DR. ALLEN O. WHIPPLE said there were certain points in connection with the topic of the evening which he wished to discuss. The first was in regard to the technic, especially in cases where jejunostomy is done as a temporary measure. As a permanent measure Doctor Barber's method would have greater advantages over the tube method. In regard to bringing the jejunum up to the abdominal wall the speaker differed with Doctor Auchincloss. His feeling in regard to the making of a temporary jejunostomy is that this should be as simple as possible and he was glad to see from Doctor Barber's presentation that the Kader produces less obstruction than the Witzel. It has been his practice to insert a rubber catheter, suturing the tube into the edges of the opening in the jejunum and then tying the purse-string suture fairly snug. He does not tie it too tight for fear of interfering with the normal blood supply which is a great safeguard. He never uses omentum as it does not build up barriers around the jejunum. One has to trust the peritoneum to take care of the barriers to be built up against leakage. He has seen severe fistula follow bringing the jejunum up to the abdominal wall. He had been interested in going over the post-mortem findings in cases in which jejunostomy had been done since the Presbyterian Hospital moved up to 168th Street. There have been seven cases so examined during the last four years in which jejunostomy was used and the patients came ultimately to autopsy. In none did peritonitis result from the jejunostomy. One died of hæmorrhage where the incision was made in the left rectus. It is his custom to use a pericostal incision near the outer border of the rectus. In none was there peritonitis or death occurring from leakage. In none of these cases was the jejunostomy a factor in hastening the end. There was one interesting thing: that was the red, congested appearance of the jejunum to which Doctor Barber alluded, and in one case multiple ulcers were present.

DR. SEWARD ERDMAN said that he believed that too many jejunostomies had been performed in the past but surgeons are now learning the limitations as well as the proper indications for their use. Regarding the animal experiments reported by Doctor Barber, he was surprised to see that leakage had occurred into the peritoneal cavity in a number of instances, within the short space of two days, where the Stamm-Kader method and an omental

flap had been used, and the abdominal wall closed about the tube. Such an occurrence would constitute a serious menace to the patient. Irrespective of whether omentum has been used or not, one would expect that the snug suturing about the tube in the intestinal wall would keep it watertight for more than two days.

On the Second Division of the New York Hospital, they have used the Witzel method almost exclusively and the wound is left open except for closure of the peritoneum.

The rubber tube is not sutured to the gut at any point, but may be fastened to the skin by one loose suture, to aid in retention.

The Witzel suture line is fastened by one suture to the parietal peritoneum. Even very early, if indicated by non-drainage, one may safely clear the tube by gentle syringe irrigation, and without leakage for several days. In any event the leakage will come out of the wound, avoiding contamination of the peritoneum.

As the tube is not sutured to the intestinal wall, it may be readily shifted, by slight rotation, or pushed a bit farther in, or partially withdrawn, without disturbing its function.

Usually the tube has served its purpose and can be withdrawn in about five days, after which there is practically no leakage and the wound closes promptly by granulation.

DR. HENRY F. GRAHAM commented on the fact that nothing had been said regarding the suture material used. That is a very important factor. In operating in the different hospitals one has to use the material at hand. In one an atraumatic suture is used, the purpose being to get away from the loop in the eye of the needle. The speaker once had a bad case of obstruction in this hospital where plain suture material was used. The patient died and the pathologist thought the peritonitis was most marked around the site of the jejunostomy. One should use either chromic or silk of some kind. Doctor Graham said he did not use an ordinary catheter because it does not drain properly. He prefers to use a tube the same size as a catheter with a few openings in the side and one on the end because this causes more easy drainage. He has noted that the cases which drain profusely for the first twenty-four hours are the ones that get well and the ones that do not drain do not get well.

DR. HOWARD LILIENTHAL said he did not know what method Doctor Barber used during operation to block the gut, but he was firmly convinced, as he has frequently expressed himself before this Society, that a large piece of rubber dam with a small hole punched in the middle makes the best occlusion for the loop of gut during the operation. The little hole is stretched by the operator, or an assistant, while a generous loop of gut is drawn through it and the rubber sheet is permitted to contract thus isolating the part to be operated upon. Nearly all his jejunostomies have been performed for obstruction combined or not with peritonitis. He also uses a fine tube

instead of a catheter because the lumen of the tube compared with the outside measure is greater than that of the usual thick-walled catheter. He has always used the Witzel method in the small intestine and he anchors the tube to the opening in the gut by a single suture of fine catgut. This gut disappears in two or three days so that there is no trouble in moving the tube. Doctor Lilienthal, however, does not often move the tube from its position but if stoppage takes place he injects a little air or water through the tube for relief. He does not angulate the gut by suturing it to the parietal peritoneum. Should leaking occur later on there is no cause for alarm for by that time a sinus will have formed and the leaking material does not contaminate the surrounding healthy parts. He has always advised that jejunostomy should precede resection of the thoracic œsophagus because œsophagogastrostomy can then be performed by drawing the stomach up into the mediastinum through an enlarged opening in the diaphragm. This would be difficult or impossible if gastrostomy had been performed instead of jejunostomy. Fine silk is better than catgut in many of Witzel's operations because it takes longer to cut through the gut wall and eventually disappears. Doctor Eliot once showed a specimen in which, at post-mortem years after a large intestinal resection with hundreds of silk ligatures, not a single stitch remained.

DR. HUGH AUCHINCLOSS said that he believed if in doing a jejunostomy one let the gut go back very far there are risks run quite as great as if the gut is brought close to the abdominal wall. Although Doctor Barber argues that the leakage is greater, Doctor Auchincloss felt he would rather have any leakage occur near the wall than in the abdominal cavity. Besides, if they are made properly and no drainage required in the wound, they do not leak. The small fistulæ that occur when the tube is removed close promptly. Furthermore, it would seem preferable to have one loop of intestine with an adhesion to the anterior abdominal wall where it is easy of access if ileus subsequently did develop than several coils adherent to one another deeper in the peritoneal cavity. Emphasis should be made upon its use as a prophylaxis against obstruction. If one is going to use it one should do so early. The second thing is in regard to what one should put in a jejunostomy. If one has to put in fluids it is well to put in sterile, and very bland fluids. Five per cent. glucose is the best and next salt solution. In regard to the tube, it is the speaker's practice to make six or seven holes in the tube with a punch and for suture material he uses fine catgut crimped on the end of the needle.

DOCTOR BARBER, in closing the discussion, said that he had thought the modified technic, using the flap, combined the advantages Doctor Whipple had brought out together with the advantages of having the stomatized loop close to the abdominal wall. The sutures were protected by fresh peritoneum and the loop and flap were covered by omentum. This overlying omentum saved the jejunal loop from harmful adhesions. In answer to Doctor Erdman regarding the leakage occurring within two days, the speaker explained

that it was the very early changes going on about the tube in the intestinal loop: the seepage of digestive secretions from between the sutures or the fibrelike adhesions (represented in the drawings), that were of special interest. In certain of the experiments fine streams of digestive fluid giving a fiery-red appearance to the peritoneum and especially to the omental fat were observed within forty-eight hours. The presence of these currents of leaking fluid seemed to make impossible the formation of adhesions. The omentum confined the irritating intestinal fluid for a few hours but by the third day pools of blood-stained fluid were observed in such cases in the left lumbar gutter or pelvis. In regard to suture material, the speaker used fine chromic gut with needle attached. The question of drainage had been brought up, and in this regard Doctor Barber was in accord with Doctor Graham, who said that the cases that drain well early do well. Doctor Lilienthal's idea of using rubber dam in the place of intestinal clamps was new to the speaker and he thought he would try it in the future. He, too, did not favor the use of intestinal clamps.

STATED MEETING HELD OCTOBER 31, 1932

The President, DR. JOHN DOUGLAS, in the Chair

OSTEOMYELITIS OF THE SKULL

DR. GRANT P. PENNOYER presented a child, ten years old, who, on September 7, was taken ill with an intense headache and a temperature of 105° . A reddened, swollen, well-demarcated area of inflammation was on the centre of her forehead. She was kept in bed nine days with marked improvement. An area of fluctuation then appeared in the forehead into which was made a small incision on September 18, 1932. A profuse discharge of pus was obtained, which continued. When it was attempted to irrigate the cavity, the irrigating fluid came out of her nose. The patient's eyes and forehead, at times, became very œdematous, and the patient was referred to the hospital. This patient had had very little trouble with colds and nasal discharge, and no apparent rhinitis or respiratory infection just before the onset of this illness. She was admitted to the Roosevelt Hospital October 13, 1932. She seems quite well except for the remarkable local condition. She has no fever, no headache, and the leucocyte count is 10,500, 68 per cent. polymorphonuclears. The Wassermann reaction is negative. The X-ray shows extensive osteomyelitis of the frontal bone extending almost to the coronal suture. The frontal sinuses are not yet developed. She seems to have some haziness in the right antrum and the ethmoidal sinuses. The Nose and Throat Department express the opinion this osteomyelitis is a result of a pan-sinusitis. A subcutaneous abscess appeared recently, and, when opened, gave exit to a small flat sequestrum. Cultures show *Staphylococcus aureus*. Conservative treatment is being adopted, opening subcutaneous abscesses as they appear. Her case is presented to illustrate the paper of the evening.

DOCTOR PENNOYER presented also a colored woman, fifty-seven years old, as the subject of osteomyelitis of the frontal bone. In August, 1931, a fluctuant, rather tender abscess appeared on her left upper frontal region just at the hair line. She had no fever and little pain. Incision and drainage

SARCOMA OF THE LOWER EXTREMITY

were done in the Out-Patient Department September 7, 1931. She has been returning ever since at frequent intervals for dressings. As the wound continued to drain, it was curetted in October, 1931, with the idea of removing any possible remaining cyst wall. A roughening of the underlying frontal bone was noted. The Wassermann reaction was negative. The wound became larger, and a few small sequestra were extruded. X-rays taken in March, 1932, showed an area of decreased bone density of the frontal bone in this region. A second Wassermann was negative, and the reaction was also negative after a provocative dose of neo-salvarsan. A prolonged course of iodides and mercury by mouth failed to give any improvement. The lesion progressed so that the meninges could be seen pulsating in the base of a deep punched-out wound which was about two and one-half centimetres across. Cultures showed *Staphylococcus aureus* and no fungi or higher forms of bacteria. Biopsy of the tissue showed simple inflammatory granulation tissue. A recent X-ray shows the process well demarcated and she is now about healed. Three X-ray-therapy treatments given last September seemed to have helped her considerably. This is apparently a primary chronic osteomyelitis of the frontal bone.

SARCOMA OF THE LOWER EXTREMITY

Well After Five Years

DR. GRANT P. PENNOYER presented a woman, forty-five years of age, who was admitted January 7, 1926, to the Roosevelt Hospital with a three-months' history of a rapidly growing tumor on the left thigh. She recalls an injury to this region about four months before which was considered of no consequence. The tumor was hard, was attached to the muscles and measured about seven by four centimetres. There were no palpable lymph-nodes of any size, and blood Wassermann examination, X-ray of chest and general examination yielded no further helpful information. Instead of simple excision, a more thorough operation was done. Careful examination of the location of the tumor in relation to the muscular anatomy established the fact that the growth lay in the superficial adductors of the thigh. Instead of dissecting right down on the tumor, a wide excision of the skin and fat over the tumor was done. The sartorius, gracilis, and adductor longus muscles were divided near their origin, far above the upper limit of the tumor, and the cleavage planes of their deep surface followed downward to well below the region of the tumor. This allowed removal of the tumor along with the underlying fasciæ and muscles, and the overlying tissue and skin, all in one piece with no manipulation in the immediate region of the neoplasm.

The pathological report by Dr. Wm. C. White is as follows: "The specimen consists of a firm, fibrous mass, poorly encapsulated, seven by four by four centimetres, along with a considerable amount of muscle, fat, and overlying skin. There is a definite invasion of the muscle by the tumor tissue. Sections show a very immature, cellular fibrous tissue with large and irregularly shaped nuclei. Some of the nuclei are vesicular, others hyperchromatic. Mitotic figures are abundant. Some regions are very cellular, in others the nuclei are isolated in fibrous tissue."

Diagnosis.—Spindle-cell fibrosarcoma. Doctor Ewing made the diagnosis of very malignant neurogenic sarcoma. The slides were again reviewed by Doctor Ewing and Doctor Stewart of the Memorial Hospital and by the pathologist of Roosevelt Hospital, Dr. Sophian. All agree recovery from this type of tumor is very rare. The patient is apparently well, and it is now almost

seven years since her operation. The loss of these muscles has caused no impairment in function.

A man, aged thirty-five years, was admitted to Roosevelt Hospital August 1, 1927, having a painless, slightly tender, rather soft mass in his right popliteal fossa which had been definitely growing for nine months. It was rather fixed to the deep soft parts but had no attachment to the skin. At operation it proved to be a peculiar multilocular cystic process imbedded in the soft tissue of the popliteal fossa and definitely invading the outer head of the gastrocnemius muscle. The cysts contained clear gelatinous material. A seemingly thorough excision was done. It recurred promptly. He was readmitted to the hospital February 20, 1928, and again excised. At this operation a much longer incision was made sacrificing the skin over the tumor. The outer head of the gastrocnemius muscle was divided at its origin and its deep surface followed downward a considerable distance below the tumor. This made it possible to remove the tumor with it and the overlying skin and fat all in one piece without any dissection in the immediate region of the diseased tissue.

The pathological report by Dr. Wm. White and confirmed by Dr. James Ewing was a myxosarcoma. The central portion of the tissue was infiltrated by a soft gelatinous tissue giving the appearance of multiple, small, thin walled cysts. Microscopical sections show the muscle infiltrated with a myxomatous material not very cellular. In places are embryonic connective-tissue cells lying in a meshwork of delicate and coarse fibrils which stain blue. The cells vary widely in shape and size. There are no mitotic figures.

This is not nearly so malignant a tumor as the former case, but it is definitely malignant. He was given a series of three prophylactic treatments of X-ray therapy. About a year later the patient thought he had a recurrence in his scar and applied to another hospital where the tissue was excised, but no tumor tissue was found. This was confirmed by Dr. Francis Carter Wood. They also gave him some radium treatment. He has remained well to date.

These two cases emphasize the fact that by study of the anatomical relations of a malignant tumor of the soft parts, it may be possible to remove that tumor with the underlying muscles and fasciæ and the overlying fat and skin all in one piece without any dissection or trauma in the immediate region of the tumor.

In breast surgery local excision of a malignant tumor is recognized as even worse than useless and we remove the whole region with its underlying muscles and fasciæ in which lies the lymphatic circulation. The same principle is applicable to the extremities. The lymphatic circulation of a region follows largely the fascial planes of the muscles which are removed by this type of operation. Equally important is the lack of trauma to the immediate tumor region.

DR. GEORGE H. SEMKEN remarked that in operations upon malignant new growths of the lower extremities, the bloodless field is of great advantage, but the use of the Esmarch bandage, the tourniquet, or even the Sehrt apparatus is open to the objection that tumor plugs in the lymphatic or blood-vessels may be dislodged by the pressure and may produce distant metastases (as

SARCOMA OF THE LOWER EXTREMITY

against purely local recurrence or regional metastasis alone). An alternative in producing a relative ischæmia is the exposure of the femoral artery in the groin, and its control by traction-angulation with a temporary, untied ligature. The ligature is placed distal to the three upper superficial branches. The collateral circulation, via branches of the internal and external iliac arteries (mainly the superior and inferior gluteal branches of the internal iliac), will not cause troublesome bleeding during the excision operation. The long ends of the ligature are allowed to emerge from the sutured wound, and the ligature is removed at the end of the desired period of ischæmia, to restore the full blood supply. It is desirable to have the assistant that will later control the artery determine the amount of traction necessary to angulate the artery without injuring it, by practising this before this wound is closed. A safe method is the grasping of the ends of the ligature with a hemostat, which is then held by its handle between the thumb and middle finger as a fulcrum, while the index finger elevates the tip and exerts the necessary gentle traction upon the ligature. Meanwhile the ulnar edge of the hand rests upon the patient's thigh. The exposure of the femoral artery in the groin gives access also to the inguinal lymph-nodes for inspection or for probatory excision if indicated.

The polymorphic variations in sarcoma cases are well illustrated in the wide differences in histological structure shown in the slides of Doctor Pennoyer's two patients. These variations are more easily understood by a study of the genetic constitution of the tumor tissue. Sarcomata are tumors of mesoblastic origin. Contrary to the common belief, the mesoblast is not merely embryonal connective tissue, but, beginning as an epithelial cell group, it later retains the epithelial character in its middle segment and part of its lateral segment, and differentiates in its remaining portion, into the embryonal connective tissue. The epithelial elements form the primordia for the kidneys, adrenal cortex, and other structures. The embryonal connective tissue furnishes the primordia not alone for the skeletal and connective tissues but also for the spleen, the vascular structures and other tissues—sharing thus in the construction of nearly all of the body. An important fact in development is that all these cells may retain in latent form potentialities not brought out in the process of differentiation. [A. Fischel.]

To trace the genetic constitution of the sarcomatous tumor tissue, it is necessary to begin with the embryonic start of the type of tissue involved. Normal tissue has the three potentialities of growth, function, and differentiation. In tumor tissue, function and differentiation are either absent or variably limited, leaving the metabolic energy wholly or in greatest part for the potentiality of growth. The increased growth rate is thus readily understood. The degree of differentiation may be anything from zero to fairly advanced specialization and the morphology of the tumor will then show any of the grades of variation from undifferentiated fetal cells or fetal connective tissue through the respective stages representative of the development of those tissues in their usual normal course. Myxomatous

tissue is like fetal connective tissue. In carcinoma, the epiblastic ancestry limits the range of morphological variation and early cancers can be recognized. The mesoblast, however, both allows wide differences in morphology and does not make the beginnings of the sarcomata distinct from tissue changes due to other causes. Remnants of the function-potential, when present, may produce structural modifications. Further changes are produced, in the picture, by inflammatory changes and the incidents of tumor experience, notably autolysis and trauma.

Concerning the etiology, the frequency with which sarcoma follows a definite single trauma at the site of tumor growth apparently bears out Ribbert's theory of tumor genesis, namely, the splitting off [*Absprengung*] and isolation of small tissue groups, which then begin an independent growth. This is not the continued, uncontrolled growth of fully differentiated adult cells, but the emergence of germinal potentialities previously latent in that group.

The neurogenical sarcomata are not of necessity of a more malignant type than the sarcomata in other tissues. The nerves are formed from two germinal layers; the axial nerve fibres and the cells of the nerve sheaths are derived from the epiblast, and the remaining elements are derivatives of the mesoblastic connective tissue. The genetic disturbance in the latter may result in tumor growth varying from simple neurofibroma to a malignant type of fibrosarcoma; and the disturbance may be limited or extensive. The epiblast is not necessarily involved in the primary disturbance. The cause of the differences in the grade of malignancy is probably to be found, in largest measure, in the degree of embryonic abnormality.

EXCISION AND SKIN GRAFT FOR LARGE VARICOSE ULCER

DOCTOR PENNOYER presented a woman, fifty-three years old, to illustrate the cure of large chronic varicose ulcers by excision of the whole area, including the deep fascia, and immediate skin graft. He showed two cases of this before the society last year. The theory is that removing all the thickened scar-like deep fascia, the region receives a new blood and lymphatic circulation from the deep tissues. He had used Thiersch grafts and had obtained good results right over bare tendons, periosteum and muscle tissue. The elephantiasis and œdema in these extremities is usually much improved by this new source of lymphatic and venous drainage.

The woman now presented had had extensive ulceration and swelling of her right leg for years. She had been treated in their Out-Patient Department for two years by the injection treatment, the usual round of medications and local pressure with large rubber sponges and bandages, all without improvement. At the time of her admission she had two enormous ulcers involving most of the anterior half of her right leg associated with extensive elephantiasis. Wide excision was done March 21, 1932, after a period of two weeks' rest in bed and sterilization of the ulcers with Dakin solution. The wound produced in this case by the total excision of the area and its underlying thickened, scar-like deep fascia formed a huge excavation in the bottom of which lay exposed about eight inches of the tibia, the bare tendons and muscle bellies of all the extensor muscles of the foot and toes, and a large area of the posterior muscles. Fortunately, she had a large thigh, from

HABITUAL DISLOCATION OF THE SHOULDER

which to obtain Thiersch grafts. The grafts were held fixed by firm pressure obtained by using a large, flat, rubber sponge and the wound was not disturbed for one week. The "take" was almost 100 per cent. and she was discharged, healed, May 2, 1932. Last August a slight trauma associated with the macerating action of a wet, perspiration-soaked dressing caused a minor ulceration which healed on rest in bed. This procedure is well worth keeping in mind in cases of chronic varicose ulcer associated with œdema and elephantiasis which will not respond to simpler treatments.

DR. FENWICK BEEKMAN said that it was unfortunate that attempt was not more frequently made to heal these varicose ulcers by operative measures. Doctor Pennoyer's principle of skin grafting is very important; that is, before it is performed there must be a base to lay the graft on which has sufficient blood supply to nourish the graft. Many attempts have been made to skin graft by laying the graft on the base of the ulcer and they have not taken. Even when they have taken they have not formed good skin. The principle which should be carried out is the excision of all scar tissue down to deep fascia. As to the question of lymphatic drainage, Doctor Beekman took exception to the statement of Doctor Pennoyer that by reëstablishing this the elephantiasis and œdema of the extremity are much improved. He could not see how, by placing a layer of epidermal tissue on the skin, one could reëstablish lymphatic circulation. Of course, by getting rid of the scar tissue the lymphatics may be enabled to grow, but he could not see how new lymphatics could be laid down to drain the ulcer.

HABITUAL DISLOCATION OF THE SHOULDER. THE NICOLA OPERATION

DR. HENRY F. GRAHAM presented a man, twenty-four years of age, who, in 1928, fell and dislocated his left shoulder. It was reduced and remained well for three months and then became again dislocated. Since that time innumerable dislocations have taken place—even raising the arm would cause a dislocation. When admitted to the Methodist Hospital May 8, 1932, he stated that the shoulder had been out more than thirty times.

The operation described by Toufick Nicola was performed May 9, 1932. The steps are as follows: an incision is made along the outer side of the coracoid process and down the anterior border of the deltoid muscle for a distance of four inches. The pectoralis major is retracted inward and the deltoid outward, exposing the long head of the biceps up to its origin. The transverse humeral ligament is divided and the tendon of the biceps lifted out of the bicipital groove. The capsule of the joint is then opened in line with the tendon.

Next the tendon is cut about one inch above the muscle fibres—leaving sufficient good tendon for subsequent suture. A one-fourth-inch hole is then drilled through the head of the humerus beginning just below the transverse humeral ligament and coming out at the centre of the articular surface of the head. The elbow is flexed and a probe is passed through the drill hole and, by the aid of a silk suture, the upper end of the tendon is drawn down through and resutured to the lower end with silk. The capsule and transverse humeral ligament are sutured with catgut.

A Velpeau bandage is applied with the elbow flexed and maintained for

two weeks. Limitation of motion is prevented by complete abduction of the arm before sewing up.

When seen September 27, 1932, this patient had had no dislocation of the shoulder since operation. Motion seems nearly perfect. There is a slight limitation of abduction after the horizontal is reached.

DR. RUSSELL H. PATTERSON said that he had done this operation on six cases with excellent results. Doctor Nicola has operated on twenty-seven such cases without a recurrence. The operation is very useful also where there is a fracture of the surgical or anatomical neck of the humerus with or without dislocation of the head. The drill hole may be brought down through the two fragments and the tendon will thus hold the fragments well in place. One of Doctor Nicola's patients died from an accident five months after the operation and an autopsy was secured. Doctor Nicola found that the tendon was firmly attached to its new home and the tendon was a little larger than normal. The tendon is supposed to become attached to the bone and not glide through the new canal. When the operation was first done the tendon was brought out through the middle of the head of the humerus, but now that Doctor Nicola is bringing the tendon out through the upper third of the head of the humerus, this causes less buckling of the tendon. The biceps tendon is very strong, its tensile strength is 6,900 pounds per square inch. It takes on an average of 240 pounds to break the tendon. The incision we now use is placed midway and at right angles to the line drawn from the tip of the acromion process to the tip of the coracoid process. The incision need not be more than three inches long.

THREE GASTROENTEROSTOMIES IN THE SAME PATIENT WITH INTESTINAL OBSTRUCTION FOR AN INTERLUDE

DR. HENRY F. GRAHAM presented a man, aged thirty-four years. Years ago this patient had various attacks of pain coming on four or five hours after meals, situated in the epigastrium and relieved by soda or food. A diagnosis of duodenal ulcer was made. After a period of good health his symptoms recurred while living in Singapore. He returned to this country and a gastroenterostomy was performed in 1925. A duodenal ulcer was found at operation.

He was well for a time but eventually his same symptoms returned and gradually became worse until 1930 when a second gastroenterostomy was performed by the same surgeon.

After a few months of comfort he began again to have abdominal pain of a severe colicky nature accompanied this time by nausea. There were a number of these attacks which finally culminated on August 25, 1931, in a very intense, excruciating pain with violent vomiting. He was admitted to the Methodist Hospital on that day with an abdomen slightly distended, tense, symmetrical and slightly tender in the epigastrium. Auscultation gave a little gurgling. The Wassermann test was negative. Blood count showed over 5,000,000 red cells, 95 per cent. hæmoglobin, 8,900 white cells and 86 per cent. polymorphonuclears.

An X-ray examination and Rehfuß test were omitted because the patient was in too great pain. A gastrojejunal ulcer was considered and there was a delay of three days hoping for improvement but he became worse. The

APPENDICITIS FOLLOWED BY LIVER ABSCESS AND PLEURISY

abdomen became distended, vomiting persisted and hiccough commenced. The tinkling sounds in the abdomen also increased.

August 29 operation under neocaine intraspinally. A loop of jejunum was found united to the posterior wall of the stomach through the transverse mesocolon about three feet from the ligament of Treitz. No patent stoma could be found between the two. Coils of small intestine had slipped through the opening left by the long loop and a volvulus had occurred. The proximal gut was much distended.

The old anastomosis was separated. The opening in the jejunum was sutured with three rows of sutures and covered by a free omental graft, because the peritoneum was absent. A new posterior no loop gastroenterostomy was made. The most distended loop of bowel above the obstruction was drained by a jejunostomy tube which was brought out through a separate stab wound.

Convalescence was smooth. The temperature and pulse were elevated to 102° and to 120 per minute respectively for four days and then steadily declined. There was no post-operative vomiting. The distension rapidly disappeared and the jejunostomy tube drained profusely for seven days when it was removed. A small abscess developed in the upper end of the wound seventeen days after operation. This was opened and promptly healed. The patient was discharged one month after operation.

In the next two months he gained twenty pounds in weight. He occasionally has a little heartburn or intestinal colic but these attacks promptly subside and seem to be due to indiscretion in diet.

October 5, 1932, he reports that he is well. His weight has remained normal.

APPENDICITIS FOLLOWED BY LIVER ABSCESS AND SUPPURATIVE PLEURISY

DR. HENRY F. GRAHAM presented a man, twenty-six years of age, who was admitted to the Methodist Hospital May 20, 1931. He had been suffering from abdominal pain for one week. This was located in the right upper quadrant of the abdomen, was steady, non-radiating and was made worse on exertion.

There was no nausea nor vomiting. Examination showed tenderness in the right upper quadrant without rigidity. No mass was present.

Operation two days later under spinal anæsthesia revealed an angry red appendix which was removed. The gall-bladder was normal.

Following this operation the temperature remained high and by the eighth day had reached 103°. A blood count at this time showed 4,090,000 red cells; 70 per cent. hæmoglobin; 23,100 leucocytes and 79 per cent. polymorphonuclears. An X-ray negative of the chest showed no abnormality of lung or diaphragm except an elevation on the right side.

On the tenth day after the appendectomy portions of the ninth and tenth ribs were removed in the right axillary line. The pleural cavity was opened and the upper surface of the diaphragm palpated. A hard, smooth, round mass was felt in the top of the liver in the nipple line.

The pleura was sutured to the diaphragm around the edge of the wound and the skin was marsupialized also. The wound was packed with gauze.

Four days later a trocar was passed through the wound into the liver and pus was obtained at a depth of one and a half inches. An electric cautery was passed along the trocar and a large rubber tube inserted.

Subsequent to the liver drainage the general condition of the patient

improved, but a week later a pleurisy with effusion appeared and aspiration obtained a little serosanguinous fluid. Five days after the aspiration there was a profuse discharge of thin yellow fecal-smelling pus from the thoracotomy wound. It was then necessary to maintain both liver and pleural drainage.

A week after this a transfusion of 500 cubic centimetres was given. A Dakin's tube was inserted into the pleural cavity and irrigations of Zonite 1 in 3 were given.

July 7, 1931, there was still a large cavity present in the thorax. A month later the X-ray showed fluid in the pleural cavity and pus was aspirated. A pyo-pneumothorax was present at this time.

The patient left the hospital September 3, 1931, after an illness of fourteen weeks. He was improving rapidly but there was still a discharging wound. September 27, 1932, a year later, his weight was normal and he was in perfect health except for a small sinus one and a half inches in length which did not communicate with bone or pleura and had practically no discharge.

An X-ray picture a few days later showed slight thickening of the pleura and practically normal lung expansion and marking. The diaphragm was slightly elevated upon the right side.

AVULSION OF THE SKIN ABOUT THE ELBOW

DR. GASTON A. CARLUCCI presented a woman, thirty years of age, who was admitted January 20, 1931, to Columbus Hospital Extension with a history of having been knocked down and dragged by an automobile.

On admission she was unconscious, suffering from severe shock and nearly pulseless. Her injuries, as far as could be determined then, were two severe lacerations of the left frontal region and an extensive dirty laceration of the left upper extremity, the skin and subcutaneous tissues having been torn completely off above the elbow and stripped down to about the middle of the forearm. There were several lacerations in the muscles, particularly along the inner aspect and what appeared to be a torn cutaneous nerve was dangling loose at the side.

External heat was applied, a clysis was given, and then a continuous intravenous infusion of warm saline for about four hours, the patient absorbing about 5,000 cubic centimetres during that time. The arm was cleansed as well as possible and then a continuous warm saline dressing applied. The elbow-joint itself did not seem to be injured, and although the internal epicondyle was exposed, clinically no fracture could be made out—which later was corroborated by X-ray.

The patient rallied and gradually came out of her shock. The avulsed skin was brought up as far as possible to cover the exposed muscles and the saline dressing was continued for several days when it was changed to Dakin's solution as the edges of the skin flaps began to necrose.

This treatment was continued, adhesive straps were applied to keep the skin flaps from retracting and the devitalized parts removed from time to time. She coöperated very well and she was encouraged to flex her elbow, the wound finally becoming a clean granulating one.

About two months after the accident Thiersch grafts were applied over the raw area and most of them remained viable. The small bare areas gradually became epithelialized and the whole wound healed. The function of the elbow gradually returned so that now there is practically no limitation of any of the motions.

MALUNION OF FOREARM FRACTURE

DR. FENWICK BEEKMAN thought that more attention should be given to healing these open areas, for the more rapid the healing the less scar tissue forms and less deformities will occur. Splinting of arms and using traction to prevent deformity, like other older methods, are *passé*. The way to prevent contractures is to cover the surface of the wound with skin and the earlier this is done, the more pliable will be the scar and the less the contracture. If one examines Doctor Carlucci's case, he will see that the graft is as soft and pliable as the skin surrounding it, because Doctor Carlucci succeeded in healing the wound at a time before much granulation tissue had formed, for granulation tissue always precedes scar tissue.

MALUNION OF FOREARM FRACTURE

DR. CARLUCCI presented a man, fifty-five years of age, who was knocked down by an automobile June 1, 1932. He was treated in a hospital where a plaster case was applied and two weeks later a splint. He was seen by the reporter about five weeks after the accident. At that time he had a marked oedema of the hand and forearm, there was a decided bowing at the middle of the forearm, and he could not supinate or pronate his hand even the slightest degree without severe pain.

Radiographs taken at this time showed a double fracture of the ulna, the one at the lower third overriding about two centimetres. The radius had a single fracture at the junction of the upper and middle third with overriding of the fragments, one of them being quite close to the ulna. On account of the bowing and the possibility of a beginning cross union between the radius and ulna the condition was operated upon.

The fracture of the radius was exposed first. The callus was found firmly attached to the ulna. This was loosened and as it was impossible to overcome the overriding, about two centimetres of the bone were resected from one of the fractured ends and a Lane plate with four screws applied and the wound closed. The lower fracture of the ulna was then exposed and here again about two centimetres of the upper fragment removed with its spicules and the two ends brought together and wired. A sugar-tong plaster splint was applied and the forearm held in suspension with a bandage. There was no post-operative reaction, the patient leaving the hospital on the sixth day post-operative, the wounds healing by primary union.

OSTEOMYELITIS OF THE SKULL

DR. IRA COHEN read a paper with the above title for which see May issue of ANNALS OF SURGERY.

BRIEF COMMUNICATIONS

MUSCLE PACK TO CONTROL HÆMORRHAGE FROM THE LIVER

DURING the course of a cholecystectomy for an abscessed gall-bladder the anterior superior surface of the liver was pierced by the blade of an abdominal retractor and a large excavation resulted, the control of the hæmorrhage from which presented an unusual problem. (Figs. 1 and 2.) Mattress sutures had always been used to close tears in the edges of the liver and the cautery for raw bleeding surfaces. When faced with this large excavation in the anterior surface of the liver suturing seemed impossible, and the hæmorrhage was so violent that cauterization seemed impracticable so packing with a hot sponge was the only means at hand to temporarily control the bleeding.

While operating in the adjoining room to a brain surgeon a few days before this occurrence a request had been received for muscle to control hæmorrhage. With this in mind a large chunk of the rectus muscle was taken and stuffed into the opening in the liver; and the liver was elevated against the abdominal wall where it was held firmly during the rest of the operation for cholecystectomy. The hæmorrhagè stopped so that upon the completion of the operation the injured area in the liver was dry and a firm clot had formed, filling over the excavation in the liver and enclosing the muscle pack. The clot and muscle were left undisturbed and the abdomen closed.

During the next eighteen months several biopsy specimens were taken from the liver by cutting out a wedge of tissue from the anterior surface and filling the hole with muscle tissue upon which pressure was made for four to six minutes or until a solid clot formed to fill the hole and enmesh the muscle tissue. The biopsy specimens obtained in this way have been more satisfactory than those obtained from the liver's edge, and there has been no difficulty in controlling hæmorrhage with the muscle tissue.

The regenerative power of the liver has been very well shown when the first patient in which this procedure was used was again operated upon eighteen months later for a stone in the common duct. At the second operation the region in which the former accident had occurred was inspected and there was not the least vestige of evidence of scarring nor adhesion formation.

Attention should be called to this accident also as it might happen to anyone when doing a cholecystectomy under spinal anæsthesia that the patient may inhale or sigh deeply, forcing the liver down suddenly upon the sharp edge of a retractor, which acts like a hoe to chop out a portion of liver substance. (Fig. 1.) The assistant had lowered the handle of the retractor which brought the edge of the blade out from the abdominal wall and left the sharp edge poised above the liver. Right angle retractor blades

CONTROL OF LIVER HÆMORRHAGE

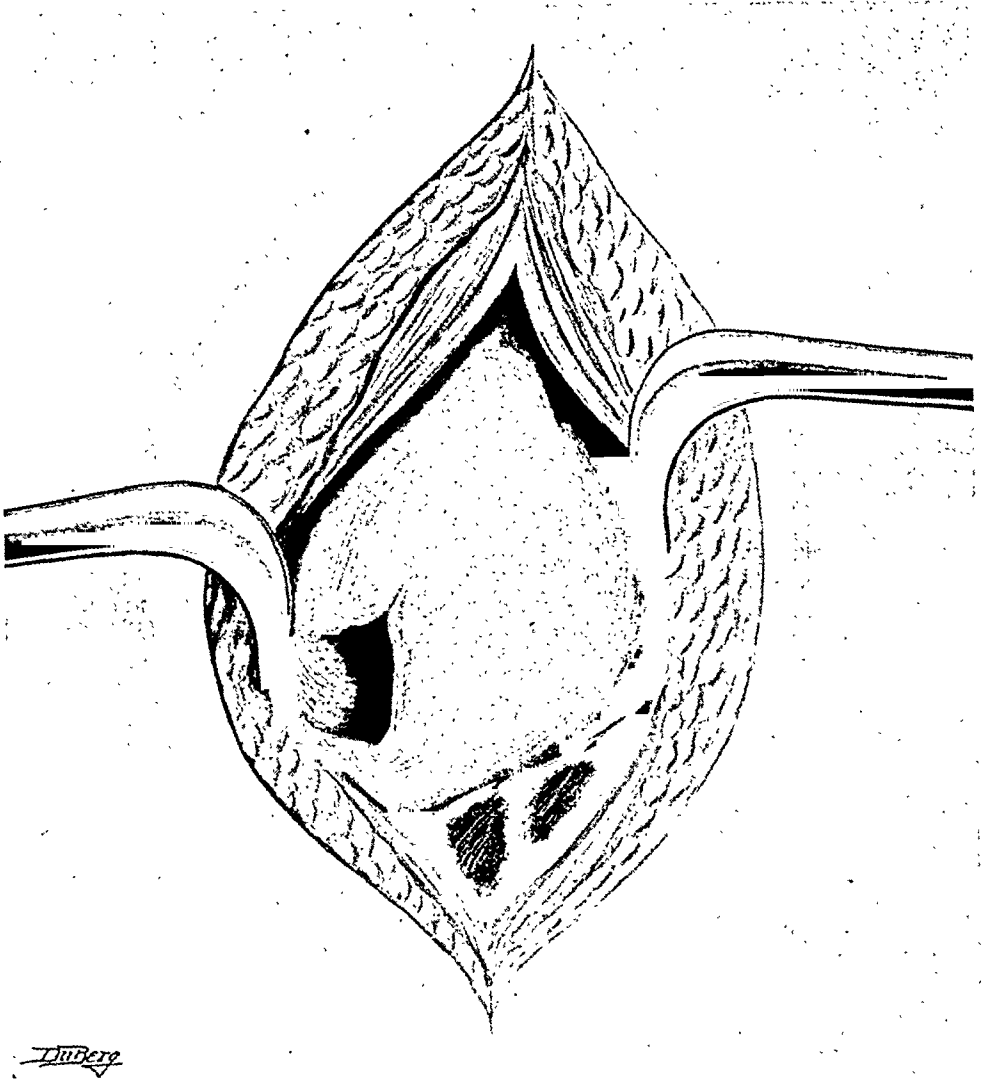


FIG. 1.

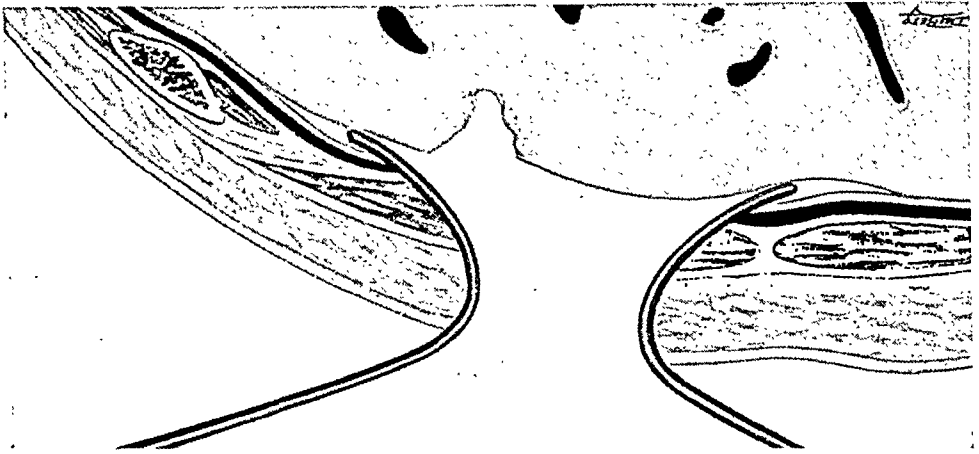


FIG. 2.

FIGS. 1 and 2.—Showing the excavation in the anterior surface of the liver made by the retractor edge upon forced inspiration with the patient under spinal anæsthesia

are especially likely to do this, therefore one should be careful to have retractors of this sort made at an acute angle so the blade will hug closely the inner surface of the abdominal wall.

R. FRANKLIN CARTER, M.D.
New York, N. Y.

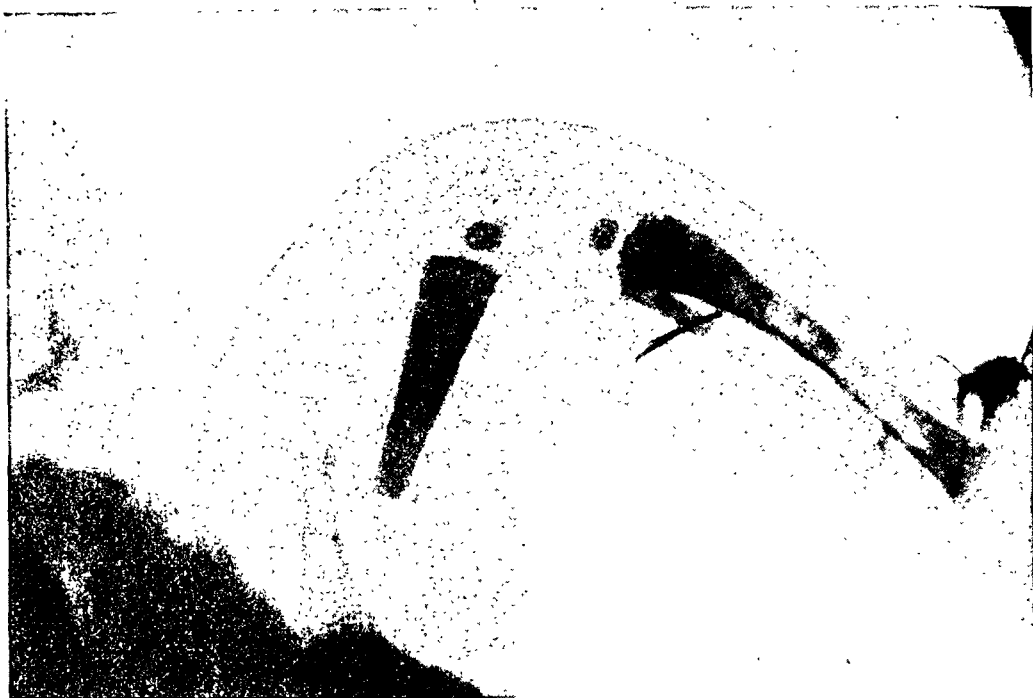


FIG. 1.—Condition when first seen at age of three weeks.

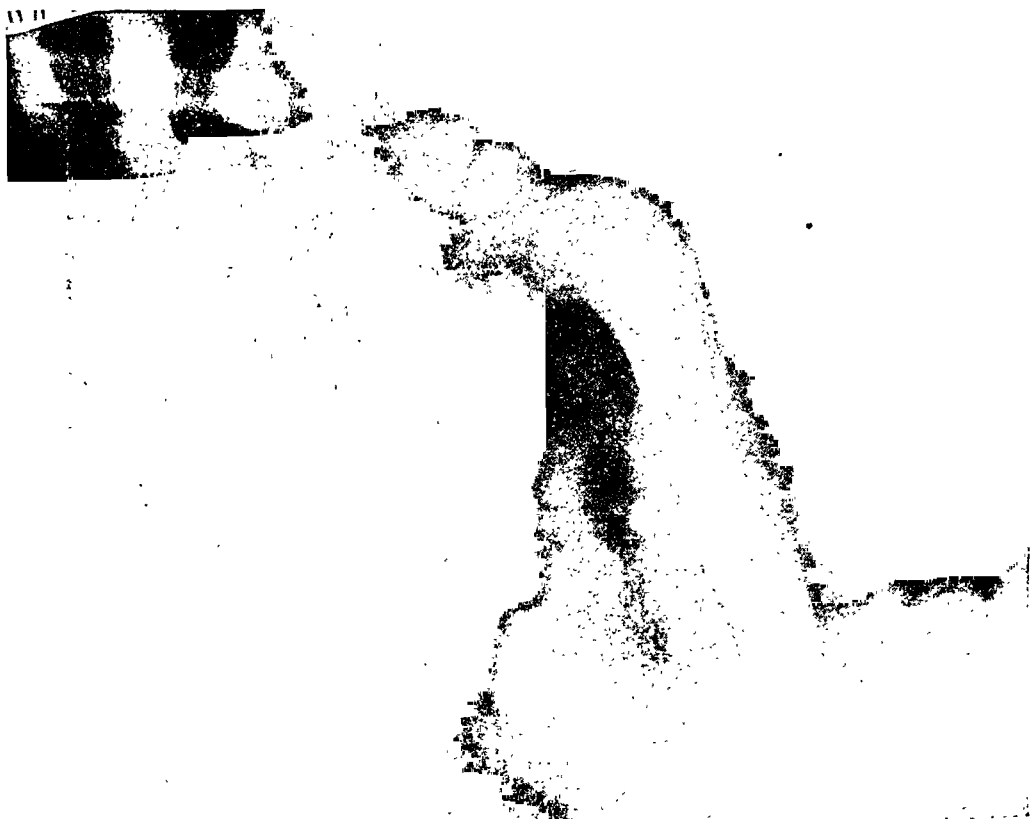


FIG. 2.—Lateral view nine weeks later.

MESENTERIC CYST OBSTRUCTING BOWEL

SPONTANEOUS CORRECTION OF BIRTH FRACTURE DEFORMITY

THE tendency toward restoration of form in fractures in young children is widely known but the following case report and X-ray pictures are an object lesson in conservatism. That I had judgment enough to advise as I did I owe to Dr. E. D. Truesdell, of New York, who first pointed out to me the incredible powers of restoration of form birth fractures show. Truesdell's experience is set forth in Scudder's Treatment of Fractures in the chapter on birth fractures. None of the femur fractures cited there recovered so rapidly or completely as this one.

A three-weeks-old infant was brought with a badly angulated and shortened left thigh due to a fracture of the shaft of the femur at birth. Some effort had been made at overhead suspension but this was soon abandoned on account of the irritation of the skin of the leg and ankle.

Examination showed a marked swelling, anterior bowing and shortening of the thigh. The skin of the thigh was badly irritated from adhesive plaster. They had a poor X-ray which (retouched) is reproduced here. (Fig. 1.) Under the fluoroscope considerable callus was seen and there was firm fixation which could scarcely be budged. The parents were anxious for *immediate operative correction*. The condition of the skin, the age of the infant and the magnitude of the undertaking in one so young precluded this. I told them I thought a good leg would result without any intervention. They finally promised not to let anything be done to the baby for six weeks and then return. They came back exactly nine weeks later. (Fig. 2.) Grossly the injured leg could not be recognized. X-rays showed the injured leg as long as the sound one and the form almost restored. Certainly no operative procedure could have done any better.

RICHARD JOSEPH WHITE, M.D.

Fort Worth, Texas

MESENTERIC CYST OBSTRUCTING BOWEL

INTESTINAL obstruction due to a mesenteric cyst is uncommon. Of 103 cases of obstruction of the bowel observed at the University of Kansas Hospital the case here reported is the first which was due to a mesenteric cyst. Of the various types of mesenteric cysts (serous, chylous, sanguinous, hydatid, dermoid, malignant, entero- and embryocystomata), it can be said that the cystomata are very frequently associated with intestinal obstruction, while the chylous cysts are infrequently associated with obstruction. The occurrence of intestinal obstruction with dermoid cysts is somewhat more frequent than with chylous cysts. Of six cases of mesenteric cyst at this hospital, some of which were found at autopsy, there were three cystomata, one chylous, one serous, and one in which the type was not stated. Only the case reported, an enterocystoma, produced an intestinal obstruction.

CASE REPORT.—Male, aged twenty-two, was admitted to the University of Kansas Hospital, complaining of pain in the abdomen, constipation and vomiting. His bowels had not moved for six days, although he had taken numerous cathartics. Vomiting and abdominal pain of a cramp-like nature began five days before admission. The patient said he had been vomiting ten to fifteen times a day. He complained of severe thirst and had been drinking much water since the onset of his illness. There was a history

of several previous attacks similar to this during the past eight years, but cathartics had given him relief.

On examination, peristalsis could be seen. His abdomen was somewhat tender. Rectal examination suggested a mass in the pelvis. His white count was 27,100 with 89 per cent. polymorphonuclear leucocytes. The blood chlorides were 230 milligrams per 100 cubic centimetres of blood, the carbon dioxide combining power was 76.8 per cent., the urea nitrogen 94.6 milligrams, and the creatinine 1.8 milligrams.

The patient was given intravenous sodium chloride solution immediately and shortly afterward a Witzel enterostomy was done. At operation the bowel was found distended and discolored. The cause of the obstruction was not determined. Due to distention a second enterostomy was done twelve hours later. There was no peritonitis found at

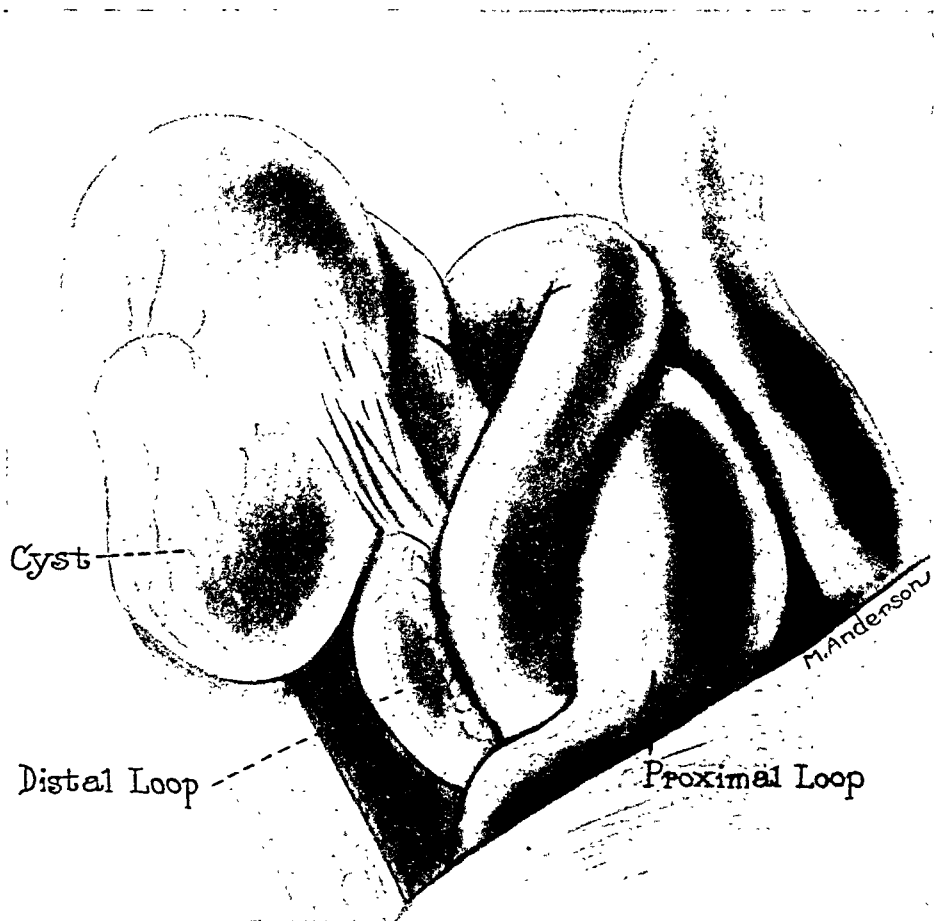


FIG. 1.—Cyst of the mesentery with volvulus of ileum in situ.

either operation. He died eight hours later. At autopsy a cyst of the mesentery near its enteric attachment, 50 centimetres from the ileocaecal valve, was found. (Fig. 1.) The cyst measured 12 by 8 by 6 centimetres and was filled with a gelatinous material. The intestine had been twisted two or three times on itself but was not strangulated. A perforation of one of the loops of intestine near the obstruction, with a generalized peritonitis, accounted for the patient's death.

Microscopical examination of the wall of the cyst showed a structure analogous to the intestine with a layer of columnar epithelium, three fairly distinct muscle layers and a serosa. Histological diagnosis was enterocystoma.

HJALMAR E. CARLSON, M.D. of Kansas City, Kansas
From the School of Medicine of the University of Kansas

ANNALS *of* SURGERY

Vol. XCVII

MAY, 1933

No. 5

AN EVALUATION OF THE TANNIC-ACID TREATMENT OF BURNS*

BY JAMES B. MASON, M.D.

OF PHILADELPHIA, PA.

IT IS desired to contrast and evaluate certain results obtained in the treatment of two series of burn cases at the Presbyterian Hospital. Particular attention is directed to the mortality statistics in children, statistics of late fatal secondary infection, and to the hospitalization as a feature of economic significance. The one series of patients received tannic therapy, while the other group was treated by a variety of methods.

Review of Experimental Literature.—While it was hardly considered within the scope of this paper to discuss the physiology of burns, there has been so much recent noteworthy experimental work that a brief mention of certain papers will serve to correlate the newer physiological concept of burns with the tannic-acid therapy. In this field the researches of Underhill and his co-workers and of Blalock and his associates have been outstanding.

When tannic acid was introduced into burn therapy, the belief was, and is yet widely held to, that this agent by coagulating the burned tissues prevented the absorption of poisonous products, and thus lessened the toxæmia. Underhill,⁹ working with dogs, has presented several bits of evidence that controvert this older contention. He found that absorption from the untreated burned surface was markedly retarded over normal skin as measured by the rate of disappearance of certain dyes. Underhill,¹⁰ in endeavoring to refute the burn toxin theory, showed that the extracts of burned tissues and like preparations of normal skin produced almost identical reactions, when injected into test animals. He stated that the altered physiology caused by blood concentration would adequately explain the toxæmia. In substantiation of Underhill's contention Harrison and Blalock⁸ have recently reported that the grafting of burned skin on a fresh wound in a healthy dog was not productive of toxæmia, and further that the transfusion of whole blood obtained from a severely burned canine donor did not produce symptoms of toxæmia in a normal dog.

Following an experimental burn there is a rapid accumulation of an œdema in the adjacent tissues. Underhill, *et al.*,^{11, 12, 13} and Beard and Blalock² have shown that this œdema fluid has essentially the chemical composition of blood plasma. In dogs, due to the structure of the skin, the œdema fluid does not escape, as in humans, into large blebs. It is gradually

* Read before the Philadelphia Academy of Surgery, October 3, 1932.

resorbed. This anatomical characteristic of the dog's skin presented a means of determining the degree of fluid loss from the circulation to the œdema. It was shown in animals, in which about one-sixth of the body area had been burned,¹¹ that there was a marked loss of fluid from the blood plasma amounting to 70 per cent. in one dog. This work was confirmed by Blalock⁴ who found that the average total fluid loss from the volume of circulating blood in eighteen animals, which had received exactly one-half of the body area burned, was 57 per cent. He suggested that the beneficial effects of tannic acid in man were probably a result of the prevention of fluid loss, rather than by the prevention of absorption of toxins.

The review of the experimental literature has brought forth certain bits of evidence, which are in harmony with, and aid in the interpretation of, clinical results of tannic-acid therapy. The concept may be adopted that the impervious non-irritating coagulum bars the loss of fluid from the circulation by preventing bleb formation, as suggested by Blalock. This lessens the degree of blood concentration somewhat, and aids in ameliorating the toxæmia attending this phenomenon. Further, the protective coagulum effects a "chemical debridement" by promptly fixing all of the devitalized cells and the underlying tissue presents a most favorable surface for the rapid ingrowth of epithelium.

Study of Mortality.—It is well known that mortality statistics have been greatly improved following the adoption of tannic-acid therapy. Beekman's³ mortality fell from 27.8 per cent. to 14.9 per cent., and Bancroft and Rogers¹ reported a reduction of from about 40 per cent. to about 20 per cent., Glover⁶ recently reported a mortality of 9.6 per cent. in a study of 310 burned patients treated by tannic acid during the years 1926 to 1931, whereas a series of 121 cases treated from 1922 to 1926 by numerous methods showed a 14 per cent. death rate.

The technic of local application of tannic acid and the general treatment of the patients have been too often described to merit discussion.

The methods of treating burns in this hospital with tannic acid was discussed in 1928 by Griffith.⁷ The only deviation from Griffith's description of technic has been in the use of stronger aqueous solutions of tannic acid than the 2½ per cent. solution recommended by Davidson.⁵ We are in agreement with Glover and others that the coagulum is more rapidly formed by the 5 per cent. and 10 per cent. fresh aqueous solutions. We have used the preparations of tannic acid suspended in water-soluble jelly base on but few cases and while the results have been uniformly satisfactory, the number of cases is too small for comment.

The many clinical benefits which Davidson and others described are too well known, and have been so often confirmed that their mention in this paper would be superfluous.

In the series of cases from the Presbyterian Hospital, there were ninety-one patients treated by many methods during the period January 1, 1922, to November 17, 1925; and ninety-seven cases treated by tannic acid during

the period November 17, 1925, to December 31, 1931, inclusive. In certain of the data, children and adults have been separated, the former comprising all patients of thirteen years and under.

Many of the adult deaths noted in Table I were the result of industrial accidents. It may be stated in this regard, that hospitals deriving their casualties largely from factories and other industries will have higher mortality rates, and this variation as to source of burned patients explains the variance of mortality figures in the literature.

The total mortality for the first series was twenty-six deaths in ninety-one patients or 28.5 per cent. Further classification showed forty-seven adults

TABLE I

Mortality

| | Total Cases | Deaths | % | Adult Cases | Adult Deaths | % | Children | Deaths | % |
|-------|----------------|--------|------|----------------|-----------------|------|----------|--------|------|
| 1922 | 18 | 4 | 22.2 | 6 | 2 | 33.3 | 12 | 2 | 16.6 |
| 1923 | 35 | 12 | 34.3 | 19 | 5 | 26.3 | 16 | 7 | 44.4 |
| 1924 | 16 | 6 | 37.5 | 10 | 4 | 40.0 | 6 | 2 | 33.3 |
| 1925 | 24 | 4 | 18.1 | 12 | 2 | 16.6 | 10 | 2 | 20.0 |
| Total | 91 | 26 | 28.5 | 47 | 13 | 27.4 | 44 | 13 | 29.5 |
| 1925 | 6 | 0 | 0 | 1 | 0 | 0 | 5 | 0 | 0 |
| 1926 | 14 | 4 | 28.5 | 8 | 3 | 37.5 | 5 | 1 | 20.0 |
| 1927 | 12 | 2 | 16.6 | 5 | 1 | 20.0 | 7 | 1 | 14.1 |
| 1928 | 20 | 2 | 10.0 | 12 | 2 | 16.6 | 8 | 0 | 0 |
| 1929 | 12 | 1 | 8.3 | 7 | 0 | 0 | 5 | 1 | 20.0 |
| 1930 | 16 | 0 | 0 | 8 | 0 | 0 | 8 | 0 | 0 |
| 1931 | 17 | 4 | 23.5 | 11 | 3 | 27.2 | 6 | 1 | 16.6 |
| Total | 97 | 13 | 13.3 | 52 | 9 | 17.3 | 45 | 4 | 9.3 |

with thirteen deaths—27.4 per cent.—and forty-four children with thirteen deaths—29.5 per cent.

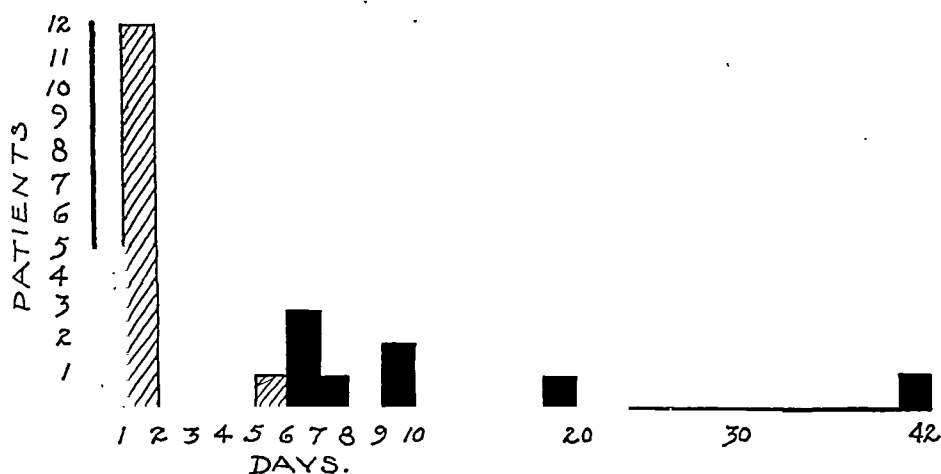
In contrast, following the adoption of tannic-acid therapy, in this series of ninety-seven patients there were thirteen deaths in all—13.3 per cent., a marked lowering of mortality. A substantial reduction of the death rate was found in the fifty-two adults with nine deaths—17.3 per cent. However, the most striking benefit of this form of therapy was shown in the forty-five children, in which group there were four deaths—9.3 per cent. This reduction of mortality by more than threefold is impressive, since the two series of children were found to be wholly comparable as to types of burns.

Late Fatal Secondary Infection.—In discussing their mortality figures, Glover⁶ and Beekman³ found that the majority of their patients who succumbed died within the first forty-eight hours, and that in the remainder

a fatal termination was the result of secondary infections, sepsis, *etc.*, at various times after this first period. Following the introduction of tannic

CHART I

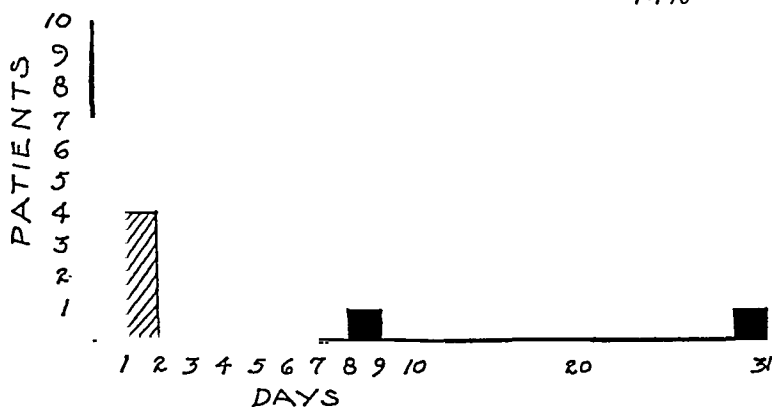
| | | |
|------------------|----|-------|
| TOTAL DEATHS | 26 | |
| WITHIN 48 HRS. | 17 | 65.4% |
| WITHIN 6-10 DAYS | 7 | 26.9% |
| AFTER 10 DAYS | 2 | 7.7% |



acid they noted fewer deaths from infections, and rightly concluded that this therapy was a factor in lowering the incidence of infections. A similar study has been made, with the results appearing in Charts I and II. It will be

CHART II

| | | |
|------------------|----|-------|
| TOTAL DEATHS | 13 | |
| WITHIN 48 HRS. | 11 | 84.6% |
| WITHIN 6-10 DAYS | 1 | 7.7% |
| AFTER 10 DAYS | 1 | 7.7% |



■ ADULTS ▨ CHILDREN

observed in these charts that before the employment of tannic acid, seventeen patients (65.4 per cent.) succumbed directly to the burn within forty-eight hours and that nine deaths (26.9 per cent.) were from infections, after the

TANNIC-ACID TREATMENT OF BURNS

first forty-eight-hour period. Contrasting with these percentages are those obtained from the series treated by tannic acid; eleven deaths occurred within forty-eight hours (84.6 per cent. of the deaths) and two deaths (15.4 per cent.) occurred after the first forty-eight hours. From these figures and on the basis of reports of other observers it is evident that tannic acid has exerted a definite influence in lowering the incidence of late fatal secondary infection of burns.

Consideration of the Morbidity and Hospitalization.—In order to determine the efficacy of a therapeutic agent, the effect upon morbidity must be obtained following a comparison of statistics of periods prior to and following its introduction. A lowering of morbidity is of definite economic consequence.

In order to determine whether the period of hospitalization was shortened following the introduction of tannic acid, it was decided to select patients from both groups, who had 20 per cent. or more of the body involved by the burn, and to study them from this point of view.

It is exceedingly difficult to foretell the length of hospitalization when the extent and degree of the burn is known. The age, sex of the patient, location and degree of the burn, infection, and the unknown factor spoken of as resistance, are all factors affecting the rate of healing. However, bearing these uncontrollable features in mind and realizing that they will affect hospitalization periods of individual patients unpredictably, we may avail ourselves of the data for discussion of this economic phase of the paper.

The increase of extensively burned patients from eleven to nineteen represents a gain of 72 per cent. (Table II.) Among both adults and children there has been a gratifying increase in the saved columns of those suffering with extensive burns. This is accomplished in some instances at the expense of increased hospitalization, although in the main, as later figures will bring out, the period of hospitalization was definitely shorter.

There seems not the slightest doubt that the little boy of four—for example—who suffered a 50 per cent. plus burn, first, second, and third degrees, and who had a total hospital stay of 525 days and who for weeks was in attendance at surgical clinic, would have succumbed to his lesion with other preliminary treatment than tannic acid.

Data on periods of hospitalization were secured from abstracts of the histories in each group. The first series showed eleven patients with 679 days spent in the hospital, an average of 61.7 days per patient. The second series of nineteen patients spent 1,016 days in the hospital, an average of 53.5 days per patient. There is an average saving of 8.2 days per patient for the tannic-acid treated series, which represents a small but definite shortening of hospitalization per patient. Were the little boy, who was hospitalized 525 days omitted, the total hospital days for the tannic-acid series would be reduced to 491 days, or an average of 27.2 days per patient, and would represent a marked reduction in morbidity and hospitalization of 34.5 days.

Similar series would probably show a figure higher than 8.2 days but less than 34.5 days. It must be apparent that there is a definite reduction of hospitalization in burn patients treated by tannic acid, and that both the patient and the hospital budgets are beneficiaries. Another economic feature

TABLE II

Morbidity

| ADULTS | | | | CHILDREN | | | |
|-------------------------------|----------------|-------------|------------------|----------|----------------|-------------|------------------|
| Age | Degree of Burn | % Body Area | Days in Hospital | Age | Degree of Burn | % Body Area | Days in Hospital |
| 1st Series 1922-November 1925 | | | | | | | |
| 22 | 1 & 2 | 25 | 24 | 7 | 2 | 20 | 120 |
| 24 | 1 & 2 | 40 | 28 | 21 mo | 1,2,3. | 20 | 41 |
| : | : | : | : | 4 | 1 & 2 | 33 1/3 | 75 |
| : | : | : | : | 4 | 2 | 30 | 140 |
| : | : | : | : | 5 | 1 & 2 | 25 | 57 |
| : | : | : | : | 7 mo | 1 & 2 | 20 | 33 |
| : | : | : | : | 6 | 1 | 20 | 11 |
| : | : | : | : | 5 | 2 | 20 | 72 |
| : | : | : | : | 22 mo. | 2 | 40 | 65 |
| 2nd Series November 1925-1931 | | | | | | | |
| 23 | 1 & 2 | 30 | 31 | 2 | 1 & 2 | 30 | 40 |
| 18 | 2 & 3 | 25 | 24 | 2 | 1 | 20 | 4 |
| 40 | 2 | 20 | 7 | 3 | 2 | 20 | 59 |
| 23 | 2 & 3 | 20 | 92 | 4 | 1 & 2 | 20 | 11 |
| 29 | 2 | 25 | 13 | 7 1/2 | 1,2,3. | 20 | 55 |
| 37 | 1,2,3. | 50 | 70 | 5 | 2 | 25 | 26 |
| 37 | 1 & 2 | 20 | 9 | 5 | 3 | 20 | 27 |
| 55 | 1,2,3 | 20 | 40 | 4 | 3 | 50 | 525 |
| : | : | : | : | 6 | 2 & 3 | 25 | 37 |
| : | : | : | : | 2 | 1 & 2 | 25 | 29 |
| : | : | : | : | 2 | 1 | 20 | 17 |

SUMMARY

of tannic-acid therapy may be briefly alluded to—the lessened cost of therapeutic agents and apparatus, and the saving of time by hospital personnel in caring for patients as contrasted to the other forms of therapy. These features represent a considerable saving per patient to the hospital.

TANNIC-ACID TREATMENT OF BURNS

(1) A brief review of the recent experimental work on the physiology of burns* with relation to tannic-acid therapy has been given.

(2) The analysis of mortality statistics showed a reduction of total mortality following the introduction of tannic-acid therapy of from 28.5 per cent. to 13.3 per cent. Of especial interest was the group of children in whom there was marked reduction from 29.5 per cent. to 9.3 per cent.

(3) Further analysis of deaths showed in the first series that 65.4 per cent. occurred within forty-eight hours and 34.6 per cent. occurred in the sepsis period, while in the second series 84.6 per cent. died within forty-eight hours, and 15.4 per cent. succumbed during the infection period.

(4) Morbidity and hospitalization were discussed and contrasted on the basis of two groups of patients, who suffered extensive burns amounting to 20 per cent. or more of the body area. In the first group there were eleven patients, who were hospitalized an average of 61.7 days per patient, while in the group treated by tannic acid there were nineteen patients, who were hospital inmates an average of 53.5 days. In this second group there was an average decrease of 8.2 hospital days per patient, which represented a small but definite economic benefit.

BIBLIOGRAPHY

¹ Bancroft, F., and Rogers, C.: The Treatment of Cutaneous Burns. *ANNALS OF SURGERY*, vol. lxxxiv, pp. 1-18, 1926.

² Beard, J. W., and Blalock, A.: The Composition of Fluid That Escapes from the Blood after Burns. *Arch. Surg.*, vol. xxii, pp. 617-625, 1931.

³ Beekman, F.: Tannic Acid Treatment of Burns. *Arch. Surg.*, vol. xviii, p. 803, 1929.

⁴ Blalock, A.: The Importance of Local Loss of Fluid in the Production of Low Blood Pressure after Burns. *Arch. Surg.*, vol. xxii, pp. 610-616, 1931.

⁵ Davidson, E. C.: Tannic Acid Treatment of Burns. *Surg., Gynec., and Obst.*, vol. xli, pp. 202-221, 1925.

⁶ Glover, D. M.: Six Years of the Tannic Acid Treatment of Burns. *Surg., Gynec., and Obst.*, vol. liv, pp. 798-805, 1932.

⁷ Griffith, G. C.: Therapy in Burns in the Presbyterian Hospital in Philadelphia. *Internat. Clin.*, vol. iv, pp. 129-131, 1928.

⁸ Harrison, W. G., and Blalock, A.: A Study of the Cause of Death Following Burns. *ANNALS OF SURGERY*, vol. xcvi, pp. 36-39, 1932.

⁹ Underhill, F. P., Kapinow, R., and Fisk, M. E.: Changes of Capillary Permeability Induced by Superficial Burns. *Am. Jour. Physiol.*, vol. xcv, pp. 315-324, 1930.

¹⁰ Underhill, F. P.: The Alleged Toxin of Burned Skin. *Jour. Lab. and Clin. Med.*, vol. xvi, pp. 823-830, 1931.

¹¹ Underhill, F. P.: The Composition of the Edema Fluid Resulting from Superficial Burns. *Am. Jour. Physiol.*, vol. xcv, pp. 330-333, 1930.

¹² Underhill, F. P., Fisk, M. E., and Kapisnow, R.: The Extent of Edema Fluid Formation Induced by Superficial Burns. *Am. Jour. Physiol.*, vol. xcv, pp. 325-329, 1930.

¹³ Underhill, F. P., Fisk, M. E., and Kapisnow, R.: Relation of Blood Chlorides to Chlorides of Edema Fluid. *Am. Jour. Physiol.*, vol. xcv, pp. 334-338, 1930.

* The burns considered were due to fire, steam, boiling water or other liquids, and electricity.

THE TREATMENT OF OLD UNHEALED BURNS

BY JOHN STAIGE DAVIS, M.D.

AND

EDWARD A. KITLOWSKI, M.D.

OF BALTIMORE, MD.

THE purpose of this paper is to call attention to that group of old (extensive) burns, which have been treated unsuccessfully elsewhere, whose healing has for one reason or another been delayed, and who have been admitted to the hospital from months to years after the original burns occurred. We will consider only the problem of healing the granulating areas and not the permanent relief of scar contractures.

These cases are seldom received with enthusiasm in a general surgical clinic on account of the length of time they must stay in the hospital and because of the great amount of medical, surgical and nursing care they require. Nevertheless, one or more of these old burns can usually be found in every large clinic, and inasmuch as they eventually have to be treated by the Plastic Division, it has become the custom here to refer them to us in the unhealed state. We believe this is a wise solution as we are interested in the healing of intractable wounds, in preventing avoidable scar contractures and in relieving these contractures when they occur.

The problem which usually presents itself is a patient in extremely poor physical and mental condition with more or less extensive unhealed areas, which are frequently complicated by serious scar contractures, or beginning scar contractions. The continuous loss of fluids through the granulating areas and the absorption from these areas, which are always infected, added to the pain and invalidism, have caused the patients to lose ground steadily and by the time they are admitted they have reached a stage of lowered vitality where progressive healing has ceased, where the granulations are unhealthy and where grafting or other operative procedures cannot be carried out successfully without a long and careful building-up process.

In order to illustrate some of the difficulties met in treating these old unhealed burns and to show the methods which were used to induce healing and which have been successful in our hands, we have selected six cases from our series at the Union Memorial Hospital, which will give an idea of some of the types encountered. Three of these patients are children and three are adults, and, for convenience, we will consider them in these two groups.

CASE REPORTS

GROUP I.—CASE I.—An eleven-year-old boy was admitted to the Union Memorial Hospital in Baltimore, June 8, 1929. In June, 1928, his clothes caught fire and he was severely burned on the right side of the body. He was taken to a hospital elsewhere for treatment and remained there for five months. He was then cared for at home until

TREATMENT OF OLD UNHEALED BURNS

his admission about one year after the accident. He was extremely emaciated and anæmic and was lying on his left side with his legs and thighs flexed. There was an unhealed area involving the right shoulder, arm and forearm down to the wrist with only one patch of epithelium about two by four centimetres just above the elbow. The forearm was flexed at the elbow and was adherent to the arm. The arm and forearm were both adherent to the chest-wall, causing complete obliteration of the axilla. The elbow was drawn backward beyond the chest-wall, thus preventing the patient from



FIG 1A



FIG 1B

Figs. 1A and B—(Case I) Condition of the patient on admission one year after being burned. Note the extensive unhealed areas, also the contractures of the right arm, thighs and legs.

lying upon his back. There was some motion in the fingers and the wrist could be partially extended passively. The hand rested upon the granulations on the chest-wall. The chest-wall and the upper abdominal wall on the right side were covered with unhealthy granulations. The right hip and right thigh on its lateral aspect were covered with very pale, œdematous and exuberant granulation tissue. Both thighs were flexed on the abdominal wall, both legs on the thighs, and could not be extended. (Figs. 1 and 2) There were some chest râles and a cough. The temperature ranged to 101° Fahrenheit.

heit daily. *Urinalysis* was negative. *Blood Examination*.—Hæmoglobin, 48 per cent. Leucocytes, 8,900. Clotting time, six minutes. The Wassermann reaction was negative. The blood group was IV.

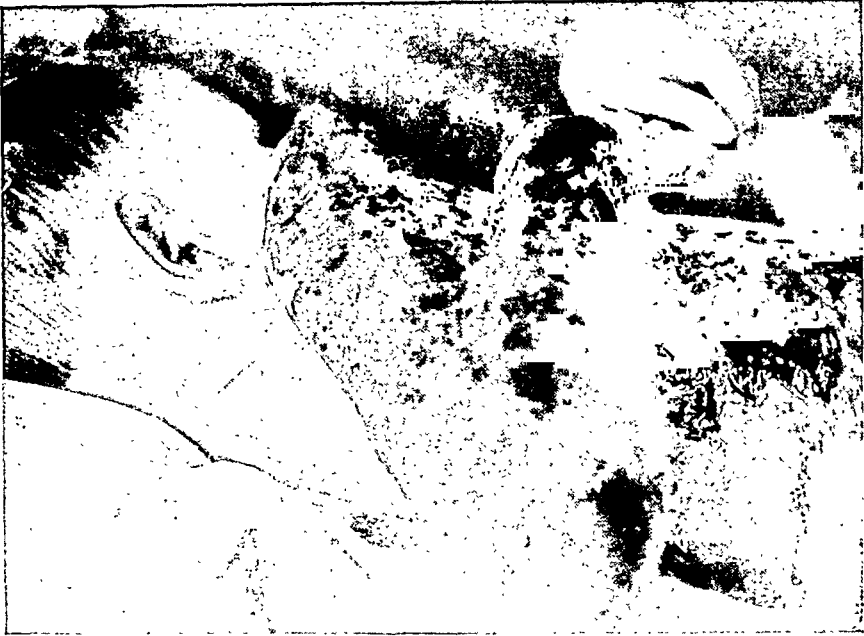


FIG. 2A.



FIG. 2B.

FIGS. 2A and B.—(Case I continued.) The right arm and forearm are adherent to each other and to the chest-wall. Note the angle at which the arm is adherent to the chest causing the elbow to be thrown backwards and preventing the patient from lying upon his back. The hand can be raised, but there was no active motion in the wrist. There is a small area of skin on the forearm near the elbow.

Progress in Hospital.—He was placed in bed upon sterile sheets under a tent kept at about 99° Fahrenheit by electric bulbs, and the granulating areas were treated in preparation for grafting. A transfusion of 250 cubic centimetres of whole citrated blood was given June 24, sixteen days after admission, which raised the hæmoglobin to 50 per cent.

TREATMENT OF OLD UNHEALED BURNS

Two days later small deep grafts were taken from the normal skin on the right abdominal wall under $\frac{1}{2}$ per cent. novocaine anaesthesia and were scattered over the whole granulating area several centimetres apart. The treatment of the grafts under closed



FIG. 3A.



FIG. 3B.

FIGS. 3A and B—(Case I continued.) One month after admission. The larger grafts had been transplanted nine days and the smaller grafts two days. Note the area upon the abdominal wall from which the first set of grafts was taken.

dressings for the next few days caused an increase in the temperature and a drop in the hæmoglobin until it fell to 43 per cent. July 5, eight days after the first grafting, small deep grafts were taken from the right lumbar region under local anaesthesia and placed in the intervals between those previously planted. (Fig. 3.) These were again suc-

cessful and the general condition of the patient began to improve so that six days after the second grafting the hæmoglobin had risen to 47 per cent. and the areas were rapidly covering with epithelium. July 15, ten days after the second grafting, another transfusion of 230 cubic centimetres of whole citrated blood was given and two days later, under nitrous oxide and oxygen anæsthesia, the adhesions between the arm and the chest-wall were partly separated, so that the arm could be brought forward. There was loss of blood and the hæmoglobin fell to 40 per cent. two days after the operation. The patient could now be placed upon his back and extension apparatus was applied to the legs to overcome the contractures. July 31 a third transfusion of 300 cubic centimetres of whole citrated blood was given and the hæmoglobin rose to 68 per cent. August 2 an attempt was made to straighten the arm at the elbow. This was only partly successful because of the danger of breaking the atrophied bones and tearing the blood-vessels and nerves. Traction was applied to the arm. August 29, small deep grafts were taken from the right buttock and placed upon the chest-wall and the arm where the adhesions had been broken. September 5, the legs were nearly straight and the hæmoglobin was 80 per cent. To hasten the healing of the few remaining uncovered areas more small deep grafts were taken from the abdominal wall under $\frac{1}{2}$ per cent.



FIG. 4A.



FIG. 4B.

FIGS. 4A and B.—(Case I continued.) Three days before discharge. Healing is complete except for an area over the elbow. Note that the arm is loosened from the chest-wall. The type of healing can be seen on the thigh.

novocaine anæsthesia and were applied in the usual manner. By October the hæmoglobin had risen to 91 per cent. and the patient was permitted to sit up in a chair. An area in the axilla which had not healed entirely was grafted October 10 with small deep grafts taken from the left abdominal wall. By the end of November, the patient was able to walk and was discharged with some contracture of the elbow and in the right groin which will have to be dealt with later. There was a single unhealed area about three centimetres in diameter over the elbow. The duration of the hospitalization was one hundred and seventy-two days. (Fig. 4.)

One year later, the patient returned for further operative work and had a well-healed durable scar. (Fig. 5.)

CASE II.—A white boy, aged three years, was admitted to the Union Memorial Hospital June 12, 1931. Seven months before admission, he was severely burned when his clothes caught fire. He was treated at home by a physician. Three weeks before admission, a fine rash appeared over the body, the face became swollen, and he ran a high temperature. The rash disappeared in a few days but the burned area began to drain much more profusely and his general condition became very much worse. He was an anæmic, emaciated boy lying upon his back with the legs flexed so that the

TREATMENT OF OLD UNHEALED BURNS

soles of his feet rested upon the bed. There was some œdema of the face and scrotum. The legs could be extended with a little force, but the patient could not extend the right thigh completely. There was an unhealed area involving the right side of the body from the axilla to the groin and the inner side of the right arm almost to the elbow. The granulations were exuberant, pale, very œdematous and infected. (Fig. 6.) The temperature was 100° Fahrenheit. *Urinalysis* was negative excepting for some actively motile bacilli. *Blood Examination*.—Red cells, 3,160,000; white cells, 14,000; hæmoglobin, 45 per cent. The Wassermann reaction was negative. The blood group was IV.

Progress in Hospital.—The patient was placed in bed upon sterile sheets under a tent heated and lighted with electric bulbs to 99° Fahrenheit. Traction was applied to



FIG. 5A.

FIG. 5B.

FIGS. 5A and B.—(Case I continued.) One year after discharge from the hospital. The healing is satisfactory and the scar is durable. Note the areas upon the abdominal wall and the buttock from which the small deep grafts had been taken. The patient has been serving a paper route since his discharge from the hospital and has returned for further work upon the elbow and wrist and right groin.

the left arm and leg in an attempt to combat contracting scar. The granulating surfaces were treated in preparation for grafting. June 17, 1931, a transfusion of 175 cubic centimetres of whole citrated blood was given. Two days later the hæmoglobin was 58 per cent. and the urine was negative. June 22, ten days after admission, small deep grafts were taken from the right thigh under $\frac{1}{2}$ per cent. novocaine anæsthesia, and were scattered over the whole area. These were successful and by July 4 the hæmoglobin was 61 per cent. and the general condition was much improved. The area was about one-half the original size by July 10 (Fig. 7) when small deep grafts were again taken from the thigh under $\frac{1}{2}$ per cent. novocaine anæsthesia and placed in the intervals between the original grafts. Both operations were done with the patient in his own bed

DAVIS AND KITLOWSKI

in about thirty minutes. The extension apparatus completely corrected the contracture of the leg (Fig. 8) and probably minimized the contraction in the axilla. In the latter part of July, a few additional small deep grafts were placed on an area near the axilla



FIG. 6.—(Case II.) Condition on admission seven months after the burn. The burn involved the right side of the body from the shoulder to the groin and the inner side of the right arm and also the axilla, almost to the elbow. The right leg could not be extended completely.

and on one near the groin to complete the healing. The patient was entirely healed and walking by the 5th of August and was discharged ten days later. (Fig. 9.) The total stay in the hospital was sixty-four days.



FIG. 7.—(Case II continued.) Five weeks after admission and three weeks after grafting was begun. The area is about one-half the original size. The arm had been kept in extension to combat contraction.

It will be necessary for this patient to return for the relief of scar contractures after six months of massage and passive motion.

TREATMENT OF OLD UNHEALED BURNS

CASE III.—A white girl, aged four years, was admitted to the Union Memorial Hospital October 14, 1930. In August, 1930, two months before admission, her clothes caught fire causing severe burns on the ears, neck, chest, arms, upper abdominal wall and on the left thigh. She had been treated elsewhere with Unguentine ointment for the first two days and then with tannic acid until October 6. Then attempts were made to remove the slough which caused pain and bleeding. The temperature began to rise as high as 104° daily and her general condition became so much worse that she was brought to Baltimore for treatment. She was an anæmic-looking girl lying in bed with the left leg flexed so that the sole of the foot rested upon the bed. There was an unhealed area involving the neck, anterior chest-wall, upper abdominal wall and both arms. The umbilicus, both nipples and the apex of the left axilla had escaped destruction. The granulating area extended to the wrist on the inner side of the left arm and to the cubital space on the right arm. There was an unhealed area five by ten centimetres on the outer aspect of the left thigh. The ears were healed. The granulations everywhere were œdematous, pale, very exuberant and infected. (Fig. 10.) There were two ulcers on the scalp over the occiput about two centimetres in diameter



FIG. 8.—(Case II continued.) Ten weeks after admission. The area is almost healed. Note the extension apparatus on the leg and the arm. The leg and thigh are completely extended. The contraction in the axilla has been minimized.

which extended down to the periosteum and there was marked œdema of the surrounding scalp. The rectal temperature on admission was 102° . *Urinalysis* showed a faint trace of albumen, positive acetone and a few granular casts. *Blood Examination*.—Red cells, 3,960,000; white cells, 11,000; hæmoglobin, 61 per cent. The grouping was IV. The Wassermann reaction was negative. The physical examination otherwise was unimportant.

Progress in Hospital.—She was placed in bed upon sterile sheets under a tent heated to 99° Fahrenheit with electric bulbs. Extension apparatus was applied to the left leg and arm. Sandbags were placed under the shoulders to extend the neck but these were only partly effective because of the very painful rapidly spreading ulcers in the scalp which had been caused by pressure. The œdema became worse and the attempts at extension of the neck had to be given up. In four days the urine was negative. She was extremely nervous and very difficult to handle and the granulations responded very slowly to treatment. In ten days the ulcers in the scalp began to improve and the extension of the neck was again started. Albumen and pus-cells appeared in the urine and the temperature rose as high as 102° daily. Râles developed in the lungs and the hæmoglobin fell to 50 per cent. A transfusion of 100 cubic centi-

metres of whole citrated blood was given under nitrous oxide and oxygen anaesthesia. The general condition began to improve again and by the end of November the hæmoglobin was 70 per cent. In spite of every effort the patient continued extremely nervous, so that all the treatment was carried out with great difficulty. (Fig. 11.) On December 2, under nitrous oxide and oxygen anaesthesia, small deep grafts were taken from the thigh and scattered over the chest, arms and the abdominal wall and Ollier-Thiersch grafts were placed on the neck after the adhesions had been divided, the granulations removed and neck extended. The Ollier-Thiersch grafts were only partially successful. The small deep grafts took nicely and two weeks later other small deep grafts were taken from the thigh, under avertin supplemented by nitrous oxide and oxygen anaesthesia, and were placed in the intervals between the small deep grafts previously applied. Improvement was rapid until December 22 when albumen and pus-cells again



FIG. 9.—(Case II continued.) The wound healed. Note the source of the grafts on the left thigh. Subsequently there will probably be some contraction of the scar in the groin and axilla, which will require relaxation at a later date.

appeared in the urine and the temperature remained high. This continued for a month despite treatment and the hæmoglobin fell to 55 per cent. A transfusion of 210 cubic centimetres of whole citrated blood was given under general anaesthesia. During the following month the hæmoglobin gradually rose to 65 per cent. and the urine cleared up. February 20, under general anaesthesia, small deep grafts were taken from the thigh and placed on the few remaining small unhealed areas. These were successful. There was a recurrence of the high temperature and the urinary condition for several weeks, after which the improvement was rapid. By March the hæmoglobin was 60 per cent. and by the end of the month it was 80 per cent. The patient was permitted to sit in a chair and was discharged June 7 after a stay in the hospital of eight months. (Fig. 12.) The use of general anaesthesia of some sort was essential in this case whenever any

special procedure was carried out on account of the extreme nervousness of the child.

This patient has since returned to the hospital for the relief of scar contractures of the neck and axilla. While at home in the interval, she has been perfectly well and has gained weight.

Analysis of Cases I, II and III.—The first three cases will be grouped as they are all children, their ages being, Case I, eleven; Case II, three; Case III, four years.

They had all been burned with fire respectively one year, seven months and two months before admission. One had had hospital and home treatment and the two others home treatment. All of this group of children were highly nervous, had learned to dread the dressings and it was very difficult

TREATMENT OF OLD UNHEALED BURNS
to gain their confidence. All were emaciated, anæmic and in very poor general condition.

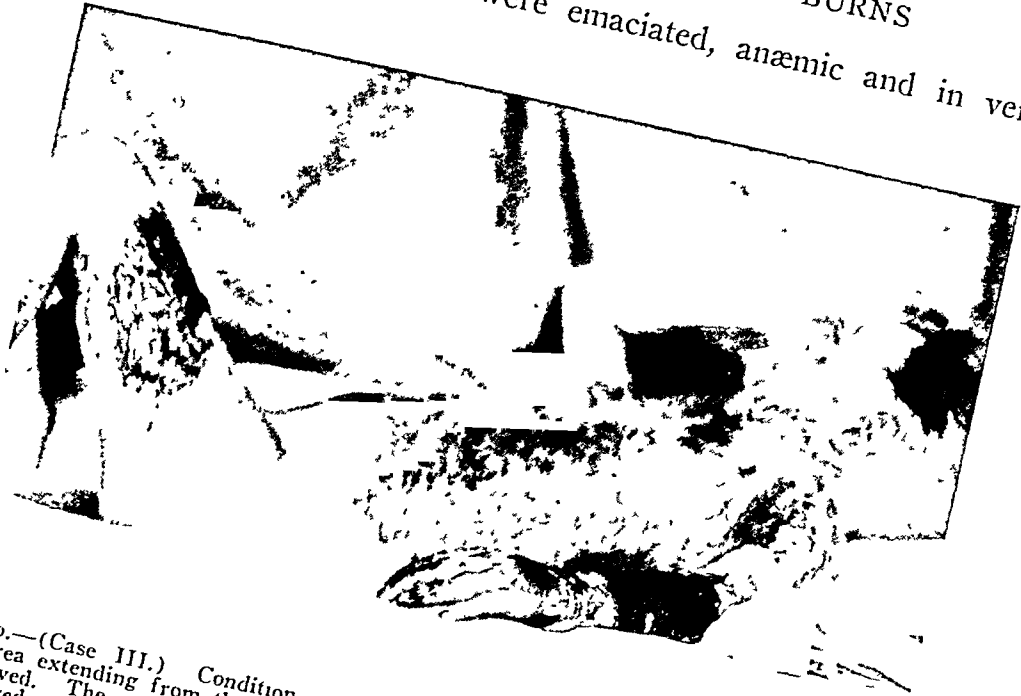


FIG. 10.—(Case III.) Condition on admission two months after the burn. There was a granulating area extending from the chin to the lower third of the abdominal wall. The right axilla was not involved. The apex of the left axilla was intact. The anterior axillary fold on the left side was covered with granulations. The left arm had been burned to the wrist and the right arm to the elbow. There was an unhealed area involving the outer aspect of the left thigh. The left leg was held flexed at right angles.

Apparent intense pain was present in all these cases. The hæmoglobin was 48 per cent., 45 per cent. and 61 per cent. respectively on admission.



FIG. 11.

FIG. 11.—(Case III continued.) Six weeks after admission. The granulations are firm and red. The right arm is healed. Much progress has been made in healing. There is already some contracture of the neck. Note the growth of epithelium from the nipples and the umbilicus, which were not destroyed. Because of the ulcers on the back of the head and on account of the general bad condition of the patient, the neck and arm could not be kept extended sufficiently to combat the scar contraction.



FIG. 12.

FIG. 12.—(Case III continued.) Condition at time of discharge. Note the contracture of the neck and some contracture of the left anterior axillary fold. The individual small deep grafts can be seen on the trunk. The healing is stable and the scar is soft. The patient was sent home for several months of massage and passive motion in order to prepare for subsequent plastic work on the neck and axilla.

All were in blood group No. IV. The Wassermann reaction was negative in all. The granulations were badly infected in all and varied from sluggish to exuberance in each case.

Marked scar contraction was already present in the eleven-year-old and three-year-old patients, who had been burned respectively one year and seven months before admission, and was well started in the four-year-old girl, who had been burned only two months before admission. Every effort was made in each case by means of extension apparatus and posture to prevent further contraction and to overcome that which had already taken place.

All of these patients were transfused, Case I, three times; Case II, once and Case III, twice.

All were grafted with small deep grafts, Case I, five times; Case II,



FIG. 13A.

FIG. 13B.

FIGS. 13A and B.—(Case IV.) Condition on admission three and one-half months after the burn. The head was almost completely denuded of skin. There is marked ectropion of both eyelids of both eyes. The granulations were pale, exuberant, very oedematous and infected. The patient's general condition was extremely poor. The entire unhealed area was exquisitely sensitive.

three times and Case III, three times; in addition, Ollier-Thiersch grafts were placed on the neck of Case III with only partial success.

In all of these cases, the main lesions were on the trunk and extremities. In only one case, III, was the neck involved. The hospitalization necessary was in Case I, one hundred seventy-two days; Case II, sixty-four days; and Case III, two hundred forty-five days.

In Case III the course of the treatment was interrupted by a number of attacks of pyelitis with high temperature and other disturbing symptoms such as extreme mental instability and nervousness. After the treatment was well started steady general improvement was noted in all. Our object in all of

TREATMENT OF OLD UNHEALED BURNS

these cases was to heal the lesions; to combat scar contractions as far as were able, then to send the patient home for massage and general building up. It was necessary for each one of them to return subsequently for the relief of scar contractions. It is probable that these contractions were considerably more marked than they would have been had we had control of the treatment from the beginning, but the situation, extent and depth of these burns and the condition of the patients would have made it very difficult for us to prevent contractions even had every precaution been taken early. In other words, scar contractions following deep burns may be impossible to prevent.



FIG. 14.—(Case IV continued.) Condition at time of discharge. The head is quite well healed but the skin is not very firm. Taking into consideration the condition at time of admission much progress had been made, but still much remained to be done. Small deep grafts were used on this case in order to cover the wound with skin so that future work could be done. From the standpoint of appearance, this was not the type of graft to use, but it was the only type which had the slightest chance of taking in this case.

GROUP II.—CASE IV.—A white male, aged forty-three years, was admitted to the Union Memorial Hospital April 1, 1928. In December, 1927, three and one-half months before admission, in a gasoline explosion, he was severely burned on the head, face, chest, upper extremities and the right leg. He was treated at home by a physician, during which time the hands healed. His general condition had become steadily worse and he came to Baltimore for treatment. The skull was denuded of skin excepting for a small patch over the left parietal region and the unhealed area was exquisitely painful. There was intense photophobia. Both ears were destroyed. The tip of the nose and the alæ had been partly destroyed. There was bilateral ectropion of both eyelids with a corneal ulcer of the right eye. There were extensive unhealed areas on the face and

neck. (Fig. 13. A-B.) The hands were claw-shaped and the fingers stiff and hyper-extended by contracted scar. There was a granulating area on the lateral aspect of the left calf five by seven centimetres in size in the midst of dense scar. The exudate from the granulations on the vertex and forehead ran down into the eyes and caused severe irritation. There was a general glandular enlargement. The heart and lungs were negative. *Urinalysis* was negative. *Blood Examination*.—Red cells, 4,620,000;



FIGS. 15A and B.—(Case V.) Condition of the inner and outer aspects of the left thigh and leg four months after the burn. The extremity was completely bare of skin from the groin to the ankle except for a patch on the outer side of the thigh and a patch over the tibia. There was scar contracture in the popliteal space. The granulations are of all types and had to be treated differently in different locations.

white cells, 14,000; hæmoglobin, 80 per cent. The Wassermann reaction was negative. The blood group was IV.

Progress in Hospital.—The granulations were prepared for grafting and an ophthalmologist was called to care for the eyes. Three days after admission small deep grafts were taken from the right thigh under $\frac{1}{2}$ per cent. novocaine and placed upon the forehead. This was done first in order to check the exudate from running into the patient's eyes. Three days later small deep grafts were placed over the back of the head

TREATMENT OF OLD UNHEALED BURNS

in order to allow the head to rest on the pillow and one week later, April 16, small deep grafts were placed over the right parietal region. April 20, small deep grafts were placed over the right post-auricular region and under the chin. Five days later, the right parietal region was grafted and one week later the crown of the head. All of these graftings were done under local anæsthesia and the grafts were placed on undisturbed granulations. The hands were massaged daily. The grafts were all successful and the healing progressed satisfactorily until July 7, when a slight infection developed on the head and face in the grafted areas. The general condition improved considerably but the patient became homesick and was discharged against our advice on the 24th of July after a hospitalization of one hundred and fifteen days. At the time of discharge the head was almost healed but the eyes could not be closed on account of bilateral



FIG. 16A.

FIG. 16B.

FIG. 16A and B.—(Case V continued) Anterior and posterior views of the leg and thigh at time of discharge. Note that the contracture in the popliteal space has been overcome and that the entire area is healed except two small superficial ulcerations on the leg.

ectropion. (Fig. 14.) Further plastic work on the lids and elsewhere was indicated at some future time.

CASE V.—A white male, aged twenty years, was admitted to the Union Memorial Hospital May 4, 1926. In January, 1926, four months before admission, he was severely burned on both hands and the left thigh and leg. He was treated in a local hospital, during which time the burns on the hands healed. Attempts at grafting the left leg and thigh had failed and little progress had been made in healing. The leg was still intensely painful. The patient was then referred to us for treatment. There was some scarring of both hands and the left wrist. The left leg and thigh were covered with unhealthy granulations from the groin to the ankle, except for an area over the upper thigh and a small area over the tibia just below the knee. The leg was flexed at right angles to the thigh. There was much pain. The granulations were pale, exuberant and

infected. (Fig. 15.) *Urinalysis* was negative. *Blood Examination*.—The hæmoglobin was 85 per cent. and the clotting time was three minutes.

Progress in Hospital.—An attempt to overcome the contraction was made by means of an extension apparatus. The granulations were prepared for grafting and three weeks after admission small deep grafts from the right thigh were scattered over those granulating areas which were suitable to receive them. June 4, small deep grafts were again



FIG. 17A and B.—(Case VI.) On admission two years and eight months after being burned. The deep ulcerations extended down to the femurs just above the knee joints. The hamstring muscles were below these ulcerations. The scar over both knees was ulcerated and the patellæ were immovably anchored about five centimetres below their normal positions. The legs were flexed at the knees at the angles shown and could not be moved. The plaster boots were attached to pulleys on a Balkan frame for traction.

taken from the right thigh and applied in the intervals between those first applied and on other areas now ready to be grafted. These were again successful and the anterior surface of the leg was healing rapidly. June 14, small deep grafts were placed in the popliteal space and July 12 the posterior and lateral aspects of the leg were grafted. These healed uneventfully and the patient was discharged well on August 12, after a stay in the hospital of ninety-eight days. (Fig. 16.)

TREATMENT OF OLD UNHEALED BURNS

Six years have elapsed since discharge and the patient has been able to continue his work and has had no further trouble.

CASE VI.—A white male, aged thirty-one years, was admitted to the Union Memorial Hospital November 13, 1931. Two years and eight months before admission, March 17, 1929, his clothes caught fire and he was severely burned on both legs and thighs. He was treated at home for one week and was then sent to a hospital where he remained for twelve weeks. At the end of that time, the legs had gradually become contracted so that the soles of the feet rested upon the bed. He was then sent home where he remained bedridden but was never completely healed. In July, 1931, deep ulcerations began to develop on both sides of both thighs just above the knees. He returned to the hospital where he remained for six weeks. Grafting was tried but was unsuccessful and amputation of both legs was advised. He refused and came to Baltimore for treatment. He was a tall, emaciated man lying upon his back with the legs flexed at the knees so that both soles rested flatly upon the bed. His general condition was very poor. In the dense contracted scar tissue, there were deep, very painful ulcerations extending down to the femurs on both sides of both thighs just above the knee-joints. These ulcerations were between the contracted hamstring muscles and bone. The patellæ were immovably anchored by deep scar about five centimetres below their normal positions. There were unhealed areas over both knees. The skin from the middle of the thighs to the calves was deeply scarred. The muscles were atrophied and "frozen" tight, and the legs were very thin. *Urinalysis* was negative. *Blood Examination.*—Hæmoglobin, 51 per cent.; clotting time, three minutes. The Wassermann reaction was negative. The blood group was IV. (Fig. 17, A-B.)



FIG. 18.—(Case VI continued.) Patient at time of discharge. Note that the contractions at the knees are almost overcome and the areas nearly healed. The deep ulcerations have filled in and the hamstring muscles are in a more normal position. The patient is able to walk with crutches. The dark spots on the skin were mercurochrome.

Progress in Hospital.—Plaster boots were made for both feet and traction applied by means of weights and pulleys on a Balkan bed. The patient was instructed to remove the weights when the pain became too severe. Massage of the healed portions of both legs and thighs was started. The ulcers were treated and improvement was gradual. Two weeks after admission the dense scars on the backs of both legs and thighs both above and below the joints were divided to relieve the tension. The tendons of the hamstrings muscles were partly cut through but not lengthened on account of neighboring infection. This was done with a cautery to prevent bleeding since the hæmoglobin was only 55 per cent. Two days later the patient developed severe pains in the right flank and a röntgenogram revealed two shadows which were diagnosed as stones in the right ureter. A transfusion of 200 cubic centimetres of whole citrated blood was given December 2 and a second transfusion was given one week later. Small deep

grafts were successfully placed on the granulations which were ready on March 14, 1932, and other similar grafts were applied to the remaining unhealed areas on March 30.

The improvement in general condition was gradual. April 20 1932, the legs are now almost straight and all the ulcers are practically healed. The right patella is now quite freely movable and the left patella is gradually loosening.

The patient is beginning to walk about the ward on crutches, and this is the first time for three years that he has been on his feet. He was discharged May 2, 1932, after one hundred sixty-eight days in the hospital. It is probable that further relaxation will eventually have to be done after function is more fully restored, but this will be comparatively simple on account of the improved condition of the tissues and improved general circulation. (Fig. 18.)

Analysis of Cases IV, V and VI.—These cases may also be grouped although their lesions were quite different. All of these were adults, their ages being, Case IV, forty-three; Case V, twenty, and Case VI, thirty-one.

Cases IV and V were burned in gasoline explosions and Case VI in an oil explosion, respectively three and one-half months, four months and thirty-two months before coming under our care.

Case IV had been treated at home, Case V in another hospital and Case VI in another hospital and at home. All of these patients suffered great pain. All were emaciated and in very poor general condition. The hæmoglobin of Case IV was high, 80 per cent., considering his general condition, as was that of Case V, 85 per cent. In Case VI, the hæmoglobin was 51 per cent. All were in blood group No. IV and in all the Wassermann reaction was negative.

The granulations varied in type from sluggish to exuberant and were infected in all. Scar contracture was marked in every case, being of a severe type in Cases IV and VI. Transfusion was done twice, Case VI. All were grafted with small deep grafts, Case IV, six times; Case V, four times and Case VI, twice.

In Case IV, the main unhealed lesions were on the head and extremities. In Cases V and VI, the lesions were on the lower extremities. The hospitalization necessary was, in Case IV, one hundred seventeen days; in Case V, ninety-eight days, and in Case VI, one hundred sixty-eight days.

In Case VI, the treatment was delayed by severe attacks of kidney pain due to stones. Steady marked improvement followed after the treatment was well started. Case IV has not returned for further treatment, although the contractures of the eyelids, *etc.*, would eventually require it. In Case V, further treatment was unnecessary. In Case VI, the patient will have to return for relaxation of the scar contractures in the popliteal space and also of the hamstring tendons.

Discussion.—By the time these patients are admitted to the hospital, their morale is usually badly shattered and every effort must be made to build this up again. Physical weakness makes them irritable and impatient, and the severe pain endured over long periods with painful dressings and the anticipation of further painful dressings is constantly on their minds. It is needless to say that extreme gentleness during dressings is essential and every effort should be made to make these dressings as free from pain as possible.

On admission all dressings were carefully removed and the patient was placed upon sterile sheets in bed and was kept warm by electrically heated and illuminated tents. This in time eliminated the fear of painful dressings, permitted the granulations to dry out and shrink, and checked some absorption from the infection, which was always present. The patients were tubbed whenever their condition was suitable. If this was not feasible, wet dressings loosely laid on saturated with either Dakin's solution; 1-5000 permanganate of potash; 1-5000 acriflavine; normal salt solution; S. T. 37; hypertonic salt solution, 5 to 15 per cent.; 20 to 40 per cent. glucose solution, *etc.*, as seemed best, were applied and changed frequently or were kept wet in order to prevent crusting.

Various antiseptics such as 5 per cent. gentian violet, 2 per cent. dahlia, 2 to 5 per cent. mercurochrome were used when needed, to overcome the infection in the granulating areas. Plain gauze, or bismuth, or iodoform gauze saturated with sterile glycerine was used, as indicated, to shrink exuberant granulations. Violet rays were also used and aided in cleaning up and shrinking the granulations where they were exuberant, and were also helpful in improving the general physical condition. All sloughing tissue, if any remained, was removed as soon as conditions were favorable. No attempts were made to trim off areas of exuberant granulations because we felt that the patients could not afford to lose any blood. Transfusions were given, whenever necessary, to raise the hæmoglobin content of the blood and to combat the infection and toxæmia, and, in many instances, this is a life-saving procedure.

The feeding of the patients was carefully supervised and every effort was made to induce them to take sufficient food of the right type. Fluids were forced to aid elimination and to replace that lost through exudation. Medication was used as indicated to allay pain, relieve nervousness, assure sleep, increase the hæmoglobin and to improve the general physical condition. Medical and pædiatric assistance in these problems was asked frequently as occasion arose.

The most skillful and faithful nursing is necessary in caring for this group of cases and much depends upon this being well done. The care of the healed areas and the unburned skin is very important as much can be accomplished by keeping these areas in good condition.

Inasmuch as all of the wounds had failed to heal under the treatment given them elsewhere and were more or less extensive, the chance of stable, unaided healing was very small. We must, therefore, weigh the different methods of hastening healing. For various reasons, the use of pedunculated flaps would, of course, be inadvisable at this period of reconstruction, so a type of free graft had to be used which could be readily secured under local anæsthesia, or very short light general anæsthesia.

The precarious condition of most of these patients contra-indicated general anæsthesia, especially since repeated grafting had to be done at short intervals.

In very nervous children such as Case III, it sometimes is necessary to use general anæsthesia even though it may be dangerous. The anæsthesia in such a case should be as short as possible and of a type which will be least likely to cause pulmonary irritation.

The larger types of grafts such as Ollier-Thiersch, half-thickness and whole-thickness grafts require a clean field for a successful take and while they can all be placed on a clean, healthy, undisturbed granulating surface and will take, this surface must be in perfect condition. These large grafts are more often placed on the raw surface left after the removal of the granulations or after excising completely the granulating area with its fibrous base. In cases of the type we are considering, we feel that the loss of blood caused by either of these operations, even though it might be small would be undesirable. In addition, the larger operative procedures necessary and the extensive areas of normal skin required to furnish these larger grafts seemed to us to be in these cases inadvisable whether under general anæsthesia or extensive infiltration. Furthermore, in some of these extensive burns, comparatively little normal skin remained which could be used as a source for the large grafts so a type of graft had to be chosen which could be secured in sufficient amounts from limited areas, especially since it was inevitable that repeated grafting would be necessary. Isografts are not sufficiently satisfactory to justify their use in these cases, particularly since there may be marked anaphylactic reaction in certain instances.

We are convinced that the most desirable type of graft to use in these cases is the "small deep graft" often referred to erroneously as the "pinch graft."* These are whole-thickness grafts in the centre tapering to the thickness of Ollier-Thiersch grafts at the edges. These grafts are sometimes confused with Reverdin grafts which consist of the epidermis with only a very thin layer of dermis. The small deep graft differs from a Reverdin graft in the same way that an Ollier-Thiersch graft differs from a whole-thickness graft. The Reverdin graft could be used in this group of cases since the source of the supply and the ability to survive are about the same as the small deep graft, but the Reverdin graft will not give as stable healing as the small deep graft because it does not contain sufficient corium to give durability to the grafted area after it is healed. The small deep grafts are not replaced by scar after healing has taken place and remain as permanently definite patches of skin. The amount of contracture in the healed area can be considerably diminished if the small deep grafts are placed fairly close

* The term *pinch graft* seems to us to be entirely out of date. At one time Reverdin grafts were obtained by pinching up a superficial bit of skin with forceps and cutting or pinching it off with scissors and on account of the method the grafts were called "pinch grafts." One frequently hears the term used also for small deep grafts, but there is no excuse for using it any longer, either for Reverdin or small deep grafts, as the use of forceps and scissors has long been abandoned by surgeons having any respect for tissues, as they cause unnecessary trauma, both in lifting and cutting the graft, and thus violate one of the fundamental surgical principles.

together. The resulting healing is very durable and can be made soft, pliable and movable by massage.

We have not attempted in these cases to bury these grafts under the granulations or use any of the other modifications sometimes suggested, because of the uniform success of the method we employ.

Large numbers of these grafts can be cut from small areas, under small amounts of local anæsthesia, so repeated grafting can be done because the amount of normal skin required to furnish these grafts need not be great. The grafts are cut about five millimetres in diameter in orderly rows leaving a small margin of skin around each graft wound to permit rapid healing in the area from which they are cut. This method conserves the normal skin to the greatest extent and permits the use of skin areas from which larger grafts or flaps could not be secured. These small deep grafts survive in the presence of some infection and can be dressed in twenty-four hours, if necessary, or be left exposed to the air if desired. They take in three or four days and grafting can be rapidly repeated to hasten healing.

As soon as the general condition of the patient was improved and the granulations were in a reasonably fair condition, grafting was commenced. It is seldom that any large granulating wound will be the same condition over its entire area at any one time, and for this reason the likelihood of successful grafting will differ in adjacent parts of the same wound. For instance, the granulations on the upper surface of a thigh may be firm, flat and clean while that on the under surface may be œdematous, infected and unfit. We therefore scattered grafts over the whole wound in suitable areas expecting a reasonable portion to take and thus secured islands of skin which stimulated the healing of the remainder. The presence of the grafts, even though they did not take, stimulated the healing and made regrafting more certain of success. In treating the cases reported, we used the small deep grafts throughout and eventually planted them at intervals of about one centimetre apart. The successive grafts were placed between those previously applied until the areas were healed.

Nature attempts to immobilize the injured parts during healing and the patient often assumes the most comfortable position, which is that of flexion, and in spite of every effort to prevent contractures by means of extension apparatus of various kinds, contractures will often occur in these cases. The extremities, even those uninjured, may be held flexed in a seriously burned case and soon because of disuse the muscles lose their tone, the tendons become shortened and the bones become atrophied. If the extremities are burned, marked deformities may be present which are caused by scar contraction.

It must be remembered that there is some contraction in every healing wound, the extent depending upon the amount of scar formation. In these extensive burns where healing had been delayed, scar formation is usually excessive and every effort must be made to minimize the amount by using

grafts which will heal the area as completely and quickly as possible and thus minimize further scar formation.

In some of these old cases, the contractures already present could not safely be overcome suddenly by force on the operating table because the blood-vessels and the nerves might be shortened and they might tear, causing gangrene and possibly a forced amputation. There was also the possibility of breaking the fragile atrophied bones. On this account an attempt was made to stretch gradually the contractures already present in the old unhealed burns by continued traction. Those which were due to posture and disuse, could be corrected by this method.

Traction was applied by means of weights and pulleys and the extremities gradually extended. The wounds were then healed with the extremities in the extended position. Massage was instituted on all healed and unburned areas and the patient was urged to move the part as much as possible.

The contractures which occurred after scar shrinkage had taken place had to be relaxed at some later date, when the patient was in better condition.

After the wounds have been healed by grafting, it is essential that the patient be sent home for six months, at least, for massage and passive motion as the scars need time for softening and releasing from deep attachments before the relaxing operations should be done. Also the patients have become, in the majority of instances, surfeited with hospital routine and need an entire change of surroundings to say nothing of a new point of view.

It was necessary for five out of six of the group of typical cases reported in this communication to return for subsequent release of scar contractures. In criticism, it might be said that the treatment used could not be particularly effective if these were the results, but when we consider that even at the late date of admission after the injury, it was frequently necessary to exert every resource at our command in order to save the lives of these patients, then an idea of the problems with which we had to deal may be appreciated.

Comments.—The condition of patients with old unhealed burns is usually very poor, both physically and mentally, and they must be thoroughly built up before skin grafting can be done successfully.

The unhealed area should be grafted as soon as the granulations are in suitable condition and healing should be induced as quickly as possible. We have found the "small deep graft" the best type to be used, as they can be obtained from comparatively small areas of skin, some of which could not be utilized to furnish larger grafts.

In these old burn cases, subsequent operative work for the release of scar contractures is almost always necessary. There has been no attempt, in this communication, to consider the methods used to obtain permanent relief of scar contractures following these old burns. Scar contraction must be combatted during treatment by suitable traction apparatus in order to minimize permanent deformity. The operative relief of scar contractures, which often occurs in most carefully treated cases, should not be attempted

TREATMENT OF OLD UNHEALED BURNS

for at least six months after healing is complete, which is about the time it takes for the scars to be loosened and softened by massage and passive motion.

From the ultimate results obtained in a considerable number of cases, we feel that the salvaging of these patients is well worth the time, the worry and the hospital days.

BIBLIOGRAPHY

- Davis, J. S., and Kitlowski, E. A.: The Immediate Contracture of Cutaneous Grafts and Its Cause. *Arch. Surg.*, vol. xxiii, p. 954, December, 1931.
- Davis, J. S.: The Small Deep Graft. *ANNALS OF SURGERY*, vol. lxxxix, p. 902, June, 1929.
- Davis, J. S.: The Small Deep Graft. *ANNALS OF SURGERY*, vol. xci, p. 633, April, 1930.

A STUDY IN EXTENSIVE CUTANEOUS BURNS*

By MONROE A. McIVER, M.D.

OF COOPERSTOWN, N. Y.

THIS paper is based on a study of sixteen patients with extensive cutaneous burns of the body and extremities. In five instances the burns proved fatal.

General Management of Patients.—The burned areas were treated by constant applications of 5 per cent. tannic-acid solution, according to the method of Davidson,¹ until a satisfactory tan was attained. The body heat was in most instances maintained by the use of electric lights under a cradle; on one occasion, where a number of burn cases were admitted at one time following an explosion in an oil refinery, the temperature of the whole room was raised and maintained at a suitable level. Fluids were forced, being administered by mouth, by rectum and in the more serious cases by either subcutaneous or intravenous injection of normal saline solution or of a 5 or 10 per cent. solution of glucose in distilled water. Morphine was administered in doses sufficient to control pain.

Types of Studies Carried Out.—In addition to making the usual records of temperature, pulse and respiration rates, daily blood counts were made and the sedimentation rate and hematocrit recorded. Frequent estimations were also made of the plasma chlorides, non-protein nitrogen, blood sugar and plasma proteins. In certain instances isolated measurements were made of the carbon-dioxide combining power and the calcium and phosphate content of the plasma. The total intake of fluid was measured and the output of urine recorded. In addition to the "routine clinical" examination of the urine, estimations of the chloride content were carried out in a number of instances. Since the fluid that accumulates in large superficial blisters may be considered typical of the fluid lost from the vascular system in burns, this was in one instance aspirated and analyzed.

Blood Counts.—The results of the count of the white and the red blood-cells are shown in Tables I and II. In most instances the initial white count was made within a few hours after the burn occurred. The findings as noted below in general confirm the early studies of Locke.²

White Blood-cells.—As will be noted from Table I, elevation of the white count is a constant finding and in the more severe cases can reach an extraordinary height within a short time. (See case No. 5.) A comparison of the counts in the fatal and the non-fatal cases shows that a high white count in general indicates a poor prognosis.

Red Blood-cells.—Locke,² in his early publication, called attention to

* Figures from the Surgical Services of the Massachusetts General Hospital with the coöperation of the Medical Service.

TABLE I. *White Blood Count*

| CASE NO. | DAY OF ILLNESS | | | | | | | | |
|----------|----------------|--------|-----------|--------|-----------|--------|--------|--------|--------|
| | 1st | 2nd | 3rd | 4th | 5th | 6th | 7th | 8th | 9th |
| 1 | 24,000 | 20,000 | 13,800 | 10,000 | 8,600 | 13,480 | 23,600 | 26,000 | 23,000 |
| 2 | 37,000 | Died a | few hours | after | admission | | | | |
| 3 | 35,000 | 56,000 | | | | | | | |
| 4 | 23,000 | 25,000 | 21,000 | 11,000 | 5,000 | | | | |
| 5 | 70,000 | Died a | few hours | after | admission | | | | |
| 6 | 17,000 | 17,000 | 29,000 | 30,000 | 26,000 | 26,000 | 24,000 | 19,000 | |
| 7 | | | 21,000 | | | | | | |
| 8 | 19,000 | 20,000 | 31,000 | | | | | | |
| 9 | 14,000 | 11,000 | 10,000 | 15,000 | 15,000 | 14,000 | | | |
| 10 | | | | | | | | | |
| 11 | 17,000 | 7,000 | 11,000 | 11,000 | 11,000 | | | | |
| 12 | | | 1,000 | | | | | | |
| 13 | 15,000 | 16,000 | 24,000 | 19,000 | 17,000 | 16,000 | | | |
| 14 | 12,000 | | 7,000 | 8,000 | 11,000 | | | | |
| 15 | | 17,000 | 13,000 | 14,000 | | | | 13,000 | |
| 16 | 22,000 | | | | | 18,000 | | | |

TABLE II. *Red Blood Count*

| CASE NO. | DAY OF ILLNESS | | | | | | | | |
|----------|----------------|-----------|-----------|-----------|-----------|-----|-----|-----|-----|
| | 1st | 2nd | 3rd | 4th | 5th | 6th | 7th | 8th | 9th |
| 1 | | 7,1 | 6,9 | 4,9 | 6,2 | | 6,0 | 6,3 | 6,0 |
| 2 | | Died a | few hours | after | admission | | | | |
| 3 | | 7,1 | | | | | | | |
| 4 | | | 5,2 | 5,3 | 5,5 | | | | |
| 5 | | | | | | | | | |
| 6 | Died a | few hours | after | admission | | | | | |
| 7 | | 5,6 | 5,8 | 5,6 | 5,4 | 5,9 | 4,9 | 5,2 | |
| 8 | 5,8 | | 5,2 | | | | | | |
| 9 | | 5,2 | 5,2 | 4,3 | 5,8 | 5,7 | | | |
| 10 | 4,0 | 4,0 | | | | | | | |
| 11 | | 5,2 | 4,7 | 4,5 | 4,6 | | | | |
| 12 | | 5,4 | 5,7 | 5,9 | | | | | |
| 13 | | 5,0 | 5,2 | 5,3 | 6,2 | 5,0 | | | |
| 14 | | 4,9 | 4,9 | 4,0 | 4,7 | | | | |
| 15 | | | 5,5 | | | | | | |
| 16 | 5,3 | | | | | 4,9 | | | |

*7,100,000; zeros omitted throughout.

the great increase in red cells that frequently occurs in cases of severe burns; one case in his series showed a count of over nine million. This author correctly interpreted this finding as a relative increase due to concentration of the blood.

In most instances of the present series, red counts were unfortunately not made on the first day of the illness. In several cases, however, a decidedly high count was found on the second day. In a few cases estimations of the red cells in both capillary and venous blood were carried out and in most instances it was found that the capillary count was definitely

higher than the venous count, indicating stasis of the blood-cells in the superficial capillary bed.

Hematocrit Readings and Sedimentation Rate.—The hematocrit readings and the sedimentation rates* are shown in Table III. The findings in two typical cases are also shown graphically in Fig. 1; one of these patients (Case I) died; the other (Case VI) recovered.

It will be noted that the characteristic findings were, in general, an increase in the percentage of red cells and a slowing of the sedimentation rate. The increased percentage of red cells is due to concentration of the blood and is roughly parallel to the severity and extent of the burn: in one fatal case (No. 1) the red cells constituted 70 per cent. of the total sample of blood, and it will be observed that some concentration persisted for as long as three days in spite of vigorous forcing of fluids. The delay in sedimentation rate is also due in part to concentration of the blood. This alone, however, is not sufficient to explain the picture, for in several cases—notably Cases

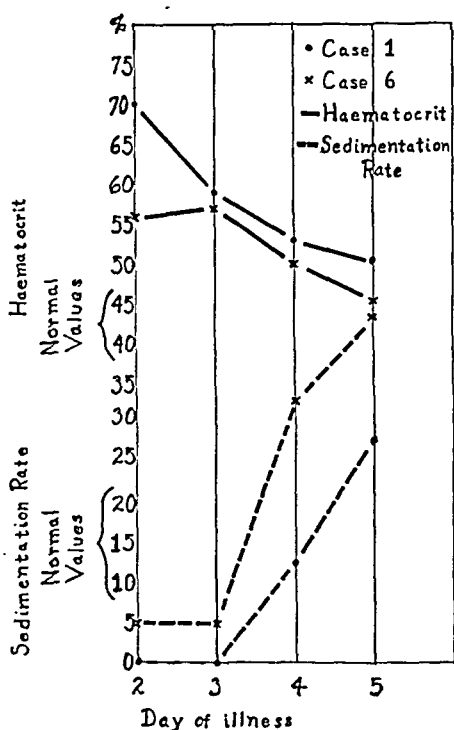


FIG. 1 in which the hematocrit and sedimentation rates on two cases over a period of five days are plotted; data from Table III. It will be noticed that on the second day of the illness there was a marked concentration of the blood, as shown by the hematocrit. In Case I the red cells constituted 70 per cent. of the total sample of blood. The rate of sedimentation was markedly slow in both patients. After vigorous administration of fluids the hematocrit readings were lower, being essentially normal by the fifth day. During this period there was an increase above normal in the sedimentation rate.

IX and X (see Table III)—marked slowing of the sedimentation rate occurred in spite of the fact that the concentration of the blood was little or not at all changed. It will be observed that after the first few days the sedimentation rate usually rose to normal or above normal levels. In certain

* The blood was drawn into glass tubes graduated from 1 to 100 mm., as described by Plass and O'Rourke.² The sedimentation rates were read at the expiration of one hour. The tubes were then placed in a centrifuge and centrifuged at high speed for twenty minutes; at the end of that time the percentage of red cells was read.

EXTENSIVE CUTANEOUS BURNS

of the cases this may have been due to a certain degree of infection in the burned areas.

Blood Chemistry.—Tables IV, V and VI show the estimations of plasma chlorides, non-protein nitrogen and total serum protein.

Plasma Chlorides.—A lowering of the blood chlorides following burns has been reported by Underhill⁴ and Davidson.⁵ * The most extensive

TABLE III
Hematocrit and Sedimentation Rates

| CASE NO. | DAY OF ILLNESS | | | | | | | | | | | | | | | | | | | | | |
|---|----------------------------------|-------|------|-------|------|-------|------|-------|------|-------|------|-------|------|-------|------|-------|------|-------|------|-------|------|-------|
| | 1st | | 2nd | | 3rd | | 4th | | 5th | | 6th | | 7th | | 8th | | 9th | | 10th | | 11th | |
| | Sed. | Haem. | Sed. | Haem. | Sed. | Haem. | Sed. | Haem. | Sed. | Haem. | Sed. | Haem. | Sed. | Haem. | Sed. | Haem. | Sed. | Haem. | Sed. | Haem. | Sed. | Haem. |
| | MM | % | MM | % | MM | % | MM | % | MM | % | MM | % | MM | % | MM | % | MM | % | MM | % | MM | % |
| 1 | | | 0 | 70 | 0 | 59 | 12.5 | 53 | 28 | 50.5 | | | 3.5 | 46 | | | | | | | | |
| 2 | Died a few hours after admission | | | | | | | | | | | | | | | | | | | | | |
| 3 | | | 2 | 44 | 0 | 47 | | | | | | | | | | | | | | | | |
| 4 | 0 | 61 | 0 | 60 | 1 | 49 | 9 | 41 | | | | | | | | | | | | | | |
| 5 | Died a few hours after admission | | | | | | | | | | | | | | | | | | | | | |
| 6 | | | 3 | 56 | 3 | 57 | 33 | 50 | 43.5 | 45.5 | | | | | | | | | | | | |
| 7 | | | | | 31 | 46.5 | | | | | | | | | | | | | | | | |
| 8 | | 36 | | 28 | | | | | 55 | | | | 55 | | | | | | | | | |
| 9 | 2 | 53 | 12 | 50 | | | 40 | 44.5 | | | | | | | | | | | | | | |
| 10 | 2 | 46 | 10 | 48 | 30 | 48 | 40.5 | 44 | | | | | | | 43 | 44 | | | | | | |
| 11 | | | 8 | 44 | 11 | 46 | | 42.5 | 12 | | | | | | | | | | | | | |
| 12 | 22 | 52 | 42 | 52 | | 50 | 38 | 52 | 34 | 46 | | | | | | | 42 | 50 | | | 42 | 52 |
| 13 | 4 | 52 | 10 | 54 | 24 | 52 | | | | | | | | | | | | | | | | |
| 14 | | | | 40 | 7 | 45 | | | 9.5 | 41.5 | | | | | | | | | | | | |
| 15 | | | | | 40 | 60 | | | | | | 74 | | | 71 | | | | | | | |
| 16 | 4 | 54 | 8 | 46 | | | | | | | 43.5 | 44 | | | | | | | | | | |
| Sedimentation rate one hour; hematocrit percentage ratio of red blood cells to plasma | | | | | | | | | | | | | | | | | | | | | | |

studies on this point were carried out by the latter author, who followed the chloride metabolism in thirty-one patients with cutaneous burns. He found in the early stages of the illness, in the more severely burned patients, an appreciable lowering of the plasma chlorides and whole blood chlorides, and also a diminished excretion of chlorides in the urine. In at least one of Davidson's patients whose record is shown in detail the chloride intake was low while the amount of ingested fluid was high. Later in the disease,

* Davidson made measurements of both the whole blood and the plasma chlorides. Underhill's, *et al.*, figures were for whole blood chlorides.

according to this author, when the slough began to separate, there occurred an elevation of the plasma chlorides and an increased output of chlorides in the urine.

The changes in the values of the plasma chlorides are probably related to the disturbance of the water balance in the three types of body fluids—the circulating, interstitial and intracellular fluids. The observations on the plasma chlorides in the present series are presented in Table IV. It will

TABLE IV
Plasma Chlorides
(Mgs. per 100 cc.)

| CASE NO. | | DAY OF ILLNESS | | | | | | | | | | | | | | |
|----------|----|----------------------------------|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|------|
| FATAL | | 1st | 2nd | 3rd | 4th | 5th | 6th | 7th | 8th | 9th | 10th | 11th | 12th | 13th | 14th | 15th |
| | 1 | 595 | 601 | 576 | | 562 | | 587 | | | | 540 | | | | |
| | 2 | Died a few hours after admission | | | | | | | | | | | | | | |
| | 3 | 632 | | | | | | | | | | | | | | |
| | 4 | 551 | 640 | | | 678 | | | | | | | | | | |
| | 5 | Died a few hours after admission | | | | | | | | | | | | | | |
| | 6 | 589 | 586 | 548 | | 541 | | | | | | | | | | |
| | 7 | | | 548 | | 584 | | | | | | | | | | |
| | 8 | 615 | 584 | | | | | 574 | | 572 | | | | | 592 | |
| | 9 | 586 | 577 | 530 | | 541 | | | | | | | | | | |
| | 10 | 590 | | | 586 | 609 | | | | | | | | | | |
| | 11 | 584 | 577 | 589 | | 595 | | | | | | | | | | |
| | 12 | 578 | 549 | 590 | | | 568 | | 548 | 559 | | 569 | | 609 | | 582 |
| | 13 | 589 | 566 | 573 | | 562 | | | | | | | | | | |
| | 14 | 578 | 607 | 582 | | 620 | | | | | | | | | | |
| | 15 | | 572 | | | | 552 | | | | | | | | | |
| | 16 | 544 | 563 | | | | 584 | | | | | | | | | |

be noted that the values are in general normal, although in several instances they are in the lower normal range. In one of the fatal cases (No. 4) the values were above normal; this patient was treated with large volumes of normal saline solution, but in spite of the larger intake of fluids and chlorides (see Table VIII) and the high plasma chlorides, the output of urine was small and its chloride content low.

Non-protein Nitrogen.—Elevation of the non-protein nitrogen of the blood following burns has been reported by Davidson^{1,5} and also by Beck and Powers.⁶ In one of the cases reported by these latter authors the blood urea was eighty milligrams per 100 cubic centimetres on the third

EXTENSIVE CUTANEOUS BURNS

day; in another instance a reading of seventy milligrams was found on the first day.

The results of the measurements of the non-protein nitrogen in the present series are shown in Table V. Case I showed a reading of fifty-nine milligrams per 100 cubic centimetres on the second day, sixty-five milligrams per 100 cubic centimetres on the seventh day and 130 milligrams per 100 cubic centimetres on the eleventh and twelfth days. Another of the fatal

TABLE V
Non-protein Nitrogen, Blood
(Mgs. per 100 cc.)

| CASE NO. | | DAY OF ILLNESS | | | | | | | | | | | | | | |
|----------|----|----------------------------------|----------------------------------|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|------|
| FATAL | | 1st | 2nd | 3rd | 4th | 5th | 6th | 7th | 8th | 9th | 10th | 11th | 12th | 13th | 14th | 15th |
| | 1 | 38 | 59 | 26 | 42 | 35 | | 65 | | | | 130 | 130 | | | |
| | 2 | 45 | Died a few hours after admission | | | | | | | | | | | | | |
| | 3 | 45 | 31 | | | | | | | | | | | | | |
| | 4 | 34 | 35 | | 66 | 140 | | | | | | | | | | |
| | 5 | Died a few hours after admission | | | | | | | | | | | | | | |
| | 6 | | | 38 | 33 | 30 | | 30 | | | | | | | | |
| | 7 | | | 47 | | 25 | | | | | | | | | | |
| | 8 | | | | | | | | | | | | | | | |
| | 9 | 37 | 31 | 32 | | 30 | | | | | | | | | | |
| | 10 | 29 | | 31 | 28 | | | | | | | | | | | |
| | 11 | 30 | 23 | 22 | | 24 | | | | | | | | | | |
| | 12 | 32 | | | | | 32 | | 37 | | | 30 | | | | 32 |
| | 13 | 27 | 27 | 22 | | 23 | | | | | | | | | | |
| | 14 | 23 | 26 | 23 | | 31 | | | | | | | | | | |
| | 15 | | 36 | | | | 34 | | | | | | | | | |
| | 16 | | 36 | | | | 25 | | | | | | | | | |

cases (No. 4) also showed a marked elevation on the fourth and fifth days; in this latter case it will be noted (Table VIII) that there was a marked suppression of urine throughout the illness. Cases II and III showed a reading of forty-five milligrams on the first day.. With these exceptions normal readings were obtained throughout the series.

Serum Protein.—The measurements of total serum protein are shown in Table VI. It will be noted that several of the cases—notably Cases I, IV and VIII—showed some lowering of the total serum protein. These measurements were made at a time when some concentration of the blood existed. (Table III.) Davidson and Matthews⁷ also found that the value of the plasma protein did not rise in proportion to the degree of concentration of the blood. They considered that this fact could be explained only

on the basis of altered permeability of the capillary walls, and concluded that it indicated a loss of the whole plasma rather than simply of the water content. I am in agreement with this conclusion. Davidson and Matthew further reported a characteristic rise in the fibrin and globulin of the plasma, while the albumin showed a fall.

Blood Sugar.—The blood sugar determinations on samples taken the first day of the illness showed, in the majority of cases, a marked increase,

TABLE VI
Serum Protein
(Expressed in Percentage)

| CASE NO. | | DAY OF ILLNESS | | | | | | | |
|----------|----|----------------------------------|--|-----|-----|-----|-----|-----|-----|
| | | 1st | 2nd | 3rd | 4th | 5th | 6th | 7th | 8th |
| FATAL | 1 | | | 4.5 | | | | | |
| | 2 | Died a few hours after admission | | | | | | | |
| | 3 | 7.3 | Before Glucose 7.5 after 5.1 | | | | | | |
| | 4 | | | 5.2 | | 4.9 | | | |
| | 5 | Died a few hours after admission | | | | | | | |
| | 6 | | | | 6.1 | | | | |
| | 7 | | | 6.4 | | 7.2 | | 6.3 | |
| | 8 | 4. | 4.5 | | | | | | |
| | 9 | | | 6.3 | | | | | |
| | 10 | 5.6 | 6.8 | 6.1 | 6.1 | 6. | | 6.1 | |
| | 11 | | | | | | | | |
| | 12 | 6.6 | | 6.5 | | | 6.2 | | |
| | 13 | | | | | | | | |
| | 14 | | | | | | | | |
| | 15 | | 7.9 | | | | 6.4 | | |
| | 16 | | 6.6 | | | | 6.9 | | |

rising as high as 266 milligrams in one case. This is probably comparable with the rise in blood sugar found in traumatic shock.⁸ The values returned to normal within the first twenty-four or forty-eight hours. In some of the less severely burned patients there was no rise.

Carbon-dioxide Combining Power.—Measurements of the carbon-dioxide combining power when taken within the first twenty-four or forty-eight hours showed essentially normal values. Patients Nos. 4 and 8 later developed a definite acidosis, Patient No. 4 on the fifth and last day of his illness having a carbon-dioxide combining power of 28.2 volumes per cent.

EXTENSIVE CUTANEOUS BURNS

Case I showed a carbon-dioxide combining power of forty-seven volumes per cent. on the second day, which fell to 38.6 volumes per cent. by the seventh day and to 24.3 volumes per cent. by the eleventh day.

Blood Calcium and Phosphates.—Isolated measurements were made of the blood calcium and phosphate. Essentially normal values were obtained, except in the case of Patient No. 4, who on the fifth day showed a blood calcium of six milligrams per 100 cubic centimetres, with a serum phosphate of 7.1 milligrams.

Blister Fluid.—It is well known that in cutaneous burns there is great leakage of fluid from the burned area and frequently a large accumulation of fluid in superficial blebs. It was felt that the fluid that gathers in such blebs might be considered typical of the fluid lost in cutaneous burns. Patient No. 8 developed large blebs over the burned area on the leg, and some ten or fifteen cubic centimetres of this fluid were aspirated under aseptic conditions and analyzed. The results of the analysis are shown in Table VII. It will be noted that the chlorides showed essentially the values of normal blood; the sugar was somewhat low; the non-protein nitrogen normal; the calcium somewhat higher than the normal range for blood. The total protein was 3.7; this figure is lower than the normal values for total serum protein, but it is evident that protein is lost in appreciable amounts.

TABLE VII

Blister Fluid, Patient No. 8

| | |
|-------------------------|-----------------|
| Chlorides | 591 mg/100 cc. |
| Sugar | 87 mg/100 cc. |
| N. P. N. | 27.5 mg/100 cc. |
| Calcium | 15.3 mg/100 cc. |
| Total Protein | 3.7% |
| White Blood-cells | 2,400 cells |

On the basis of this analysis of the blister fluid it is evident that the loss of fluid is not simply a loss of the water content of the blood, but of a substance that is closely parallel to whole plasma. *One would not, therefore, expect great changes in the individual constituents of the plasma, following burns, but rather a lowering of the total volume of plasma with a resulting concentration of the blood.*

Intake and Output of Fluids: Urinary Findings.—The intake and output of fluids during the first five days of the illness, and in certain cases the total output of chloride in the urine, are shown in Table VIII.* The fluid taken in the fatally burned cases was largely in the form of physiological

* These records were kept for twelve days, but no striking changes were found between the fifth and twelfth days, intake and output of fluids maintaining about the same rates. Case I was an exception: after the fifth day there was an increase in the excretion of fluid and chloride for several days, followed by a marked diminution in the excretion during the last few days before death, which occurred on the eleventh day.

salt solution given intravenously or subcutaneously; in certain instances 5 to 10 per cent. glucose solution was used.

The diminished output of urine and the low excretion of chlorides in spite of the large intake of fluid were striking findings in all the fatal cases. In the less severely burned cases, also, there was some suppression of urine and a low excretion of chlorides. This diminished kidney function is an important finding, and may be of fundamental significance.

Davidson⁵ has suggested that the urine chlorides are low because the blood chlorides are below the renal threshold; this may hold true in certain instances, but obviously cannot explain the low excretion of chlorides in Case IV. Davidson, whose cases were kept on a fixed sodium chloride intake, noted an increased output of the chloride of the urine at about the time the slough separated. The cases in the present report were not studied long enough to detect this late rise in chloride excretion. Several of the cases, because of the high fluid intake and low urinary secretion, developed œdema of the feet and ankles and dependent parts.

Routine clinical examination of the urine carried out in most of the cases showed the "slightest possible trace" of albumin. In one case (IV) this was recorded as "a trace" on the fifth day of the illness. A number of the fatal cases showed rare granular casts with an occasional white blood-cell. Cases I and IV in the terminal stage showed acetone and diacetic acid.

The Cause of Death.—It is not the purpose of this paper to review the enormous literature on the toxæmia of burns; reference to this will be found in the works of Pack⁹ and Pack and Davis.¹⁰ There are at the present time two principal theories as to the cause of death in extensive burns. One of the oldest and most firmly established in the literature is that the symptoms and death are due to a toxin absorbed from the devitalized or partially devitalized burned tissue. More recently, Underhill and co-workers^{4,11,12,13,14} have contended that the symptoms are due not to a circulating toxin but to the marked concentration of the blood. These authors point out that the highly concentrated blood has difficulty in passing through the capillaries; circulation is slow and aëration of the tissues deficient; the large blood-vessels are not properly filled and the heart has not sufficient blood to work upon. In consequence of the partial asphyxiation of the tissues there may be alterations in the metabolic process and disturbance of the heat-regulating mechanism and kidney function.

The fact that great concentration of the blood occurs in extensive superficial burns is beyond question (in the present series the volume of red cells, as indicated by the hematocrit, reached a figure as high as 70 per cent.; see Table III) and undoubtedly the secondary effects of this condition are profound. In spite, however, of the evidence brought forward by Underhill in support of the view that concentration of the blood is responsible for the death, it seems questionable whether this is the whole story. As shown in Tables III and VIII, a number of fatalities occurred in the present series, although the concentration of the blood was combated with large intakes

EXTENSIVE CUTANEOUS BURNS

TABLE VIII

| CASE NO | 1st Day | | | 2nd Day | | | 3rd Day | | | 4th Day | | | 5th Day | | |
|---------|------------------|------------------|----------------|----------------------------------|------------------|----------------|----------------------------------|------------------|----------------|------------------|------------------|----------------|------------------|------------------|----------------|
| | CC. FLUID INTAKE | CC. URINE OUTPUT | GMS. URINE C1' | CC. FLUID INTAKE | CC. URINE OUTPUT | GMS. URINE C1' | CC. FLUID INTAKE | CC. URINE OUTPUT | GMS. URINE C1' | CC. FLUID INTAKE | CC. URINE OUTPUT | GMS. URINE C1' | CC. FLUID INTAKE | CC. URINE OUTPUT | GMS. URINE C1' |
| 1. | 1860 | 750 | | 6420 | 1350 | | 6990 | 1440 | 3.8 | 7740 | 2550 | 5.7 | 6180 | 4500 | 3.4 |
| 2. | 4800 | 0 | 0 | Died a few hours after admission | | | Died a few hours after admission | | | | | | | | |
| 3. | 3230 | 120 | 0 | 4390 | 120 | 0 | | | | | | | | | |
| 4. | 1800 | 0 | 0 | 7650 | 450 | | 6750 | 540 | .2 | 4770 | 495 | .3 | 3480 | 660 | 1.6 |
| 5. | 1000 | 0 | 0 | Died a few hours after admission | | | Died a few hours after admission | | | | | | | | |
| 6. | 2250 | | | 4860 | 180 | | 7290 | 1080 | 1.8 | 6120 | 1410 | 1.1 | 5670 | 1230 | 1.4 |
| 7. | | | | | | | 6800 | 1535 | | 4280 | 1410 | 2.7 | 4280 | 630 | 2.5 |
| 8. | 1800 | 900 | 7.9 | 5100 | 1635 | 5.8 | 6300 | 5200 | 6.1 | 7950 | 6300 | 3.8 | 6900 | 2980 | 3.2 |
| 9. | 2310 | .510 | | 3360 | 450 | | 4800 | 1320 | | 4440 | 960 | | 5100 | 1440 | |
| 10. | | 820 | 2.4 | | 3040 | 3.6 | | 2620 | 1.6 | | 1570 | 1.1 | | 1120 | |
| 11. | 3450 | 1470 | | 3750 | 2550 | | 9300 | 2550 | | 6540 | 2670 | | 6000 | 3000 | |
| 12. | | | | | | | | | | 1200 | 2400 | 0 | 3300 | 2350 | 1.8 |
| 13. | 3810 | | | 5400 | 2550 | | 8040 | 4470 | | 6270 | 2040 | | 6990 | 4410 | |
| 14. | | | | 2250 | 600 | | 5100 | 1140 | | 6510 | 2490 | | 5250 | 840 | |
| 15. | | | | 7140 | | | 5250 | | | 5250 | 1600 | | 7150 | 1350 | |
| 16. | 5120 | 395 | 1.5 | 4480 | 1446 | | 5760 | 1230 | 2 | 4600 | 1600 | | 4160 | 730 | 0.9 |

of normal salt solution. It may be argued that in several of these cases death occurred after the acute stage had passed and may have been due to infection of the burn. This is possible in certain cases, especially in Patient No. 1, who survived eleven days; in other cases, however, it would not seem likely. All the patients were treated under as strictly aseptic conditions as possible.

Certain pathological lesions sometimes found in burn cases at autopsy have been brought forward as evidence of a circulating toxin; these are notably duodenal ulcers^{15,16,17} and hæmorrhages into the adrenals,^{16,18} although other lesions have also been reported—as, for example, cloudy swelling of the kidney and degenerative changes in the liver and central nervous system.¹⁰ Underhill¹² explains these findings on the basis of the fact that as the body is burned the heat may penetrate the body cavities deeply enough to bring about local circulatory changes of sufficient severity to cause the ulcers and hæmorrhages. This explanation seems to the author unsatisfactory; it does not seem reasonable that the heat could penetrate sufficiently to account for lesions of such deep-seated organs as the duodenum and adrenals. In Harris's case, referred to above,¹⁶ the burns were caused by boiling water, so that the surface temperature could not have been above 100° C.

In the case of a death occurring within a few hours after an extensive body burn, it seems probable that the cause is comparable to that in primary wound shock.¹⁹ The cause of death in patients who survive the effects of the preliminary shock and die later seems to the author still an open question.

Although it may not be the only factor in the cause of death, or at times even the principal factor, the importance of the concentration of the blood cannot be minimized. There is some question, however, as to whether this condition comes about simply as a result of local loss of blood plasma in the burned area, or whether there is a general lowering of capillary permeability all over the body. Underhill¹⁴ believes the loss a local one; Beard and Blalock²⁰ also agree that the local loss of plasma is sufficient to explain the symptoms. Davidson⁷ (who believes in a circulating toxin) considers that there is a general lowering of capillary permeability throughout the body. The observations made on the patients of the present series do not include any measurements that would be applicable to this point. The amount of subcutaneous œdema and swelling of a seriously burned extremity is striking and the local loss of fluid is obviously considerable; two of the patients in this series also developed some generalized œdema of the dependent parts, but this was not surprising in view of the large amounts of fluid they were receiving and the low renal output.

Treatment.—The general points in treatment have been touched on under General Management of Patients. Since concentration of the blood and lowering of the total blood volume is undoubtedly a serious condition in itself, the volume of fluid administered must be adequate to correct the condition, the amount varying with the age of the patient and the severity

EXTENSIVE CUTANEOUS BURNS

of the burn. In the case of children, where the blood volume is relatively small, the loss of a given amount of fluid is felt proportionately more. It is necessary that the administration of fluid be kept up for a number of days. It should be remembered that where large volumes of fluid are required it might be well, for at least part of the quantity given, to use isotonic glucose solution rather than physiological salt solution, so that an undue amount of sodium chloride will not be taken in. In many of the fatal cases (see Table VIII) the output of sodium chloride is low in spite of the fact that the blood chlorides are normal or even slightly above normal.

SUMMARY.—The findings may be summarized as follows:

There was an increase in the white and red blood counts, an increase in the percentage of red cells in proportion to plasma, a diminution in the sedimentation rate of the red cells. Blood-chloride values were in essentially normal range (the serious cases received large volumes of normal salt solution). Only two cases showed very striking increase in the non-protein nitrogen of the blood; these two were fatal cases and the increase was most marked in the terminal stage. Certain cases showed some lowering of the total plasma protein. When the blood sugar was determined soon after the burns occurred, it was in the most cases high. Carbon-dioxide values were essentially normal early in the disease; two patients later developed a definite acidosis.

The composition of the blister fluid closely resembled that of blood plasma.

The urinary output was low and the excretion of the chlorides diminished; this was most marked in the more severely burned cases.

CONCLUSIONS.—One of the most outstanding findings in severe burns is the marked concentration of the blood. Correction of this abnormal condition by adequate fluid intake, while important, is frequently not able to relieve all the symptoms or prevent a fatal outcome; it seems likely that there is some other important factor in the toxæmia of burns.

BIBLIOGRAPHY

- ¹ Davidson, E. C.: Tannic Acid in the Treatment of Burns. *Surg., Gynec., and Obst.*, vol. xli, pp. 202-221, August, 1925.
- ² Locke, E. A.: A Report of the Blood Examination in Ten Cases of Severe Burns of the Skin. *Boston Med. and Surg. Jour.*, vol. cxlvi, pp. 480-484, October 30, 1902.
- ³ Plass, E. D., and Rourke, M. D.: A New Procedure for Determining Blood Sedimentation Rates. *Jour. Clin. Inves.*, vol. v, pp. 531-539, June, 1928.
- ⁴ Underhill, F. P., Carrington, G. L., Kapsinow, R., and Pack, G. T.: Blood Concentration Changes in Extensive Superficial Burns, and Their Significance for Systemic Treatment. *Arch. Int. Med.*, vol. xxxii, pp. 31-49, July, 1923.
- ⁵ Davidson, E. C.: Sodium Chloride Metabolism in Cutaneous Burns and Its Possible Significance for a Rational Therapy. *Arch. Surg.*, vol. xlii, pp. 262-277, August, 1926.
- ⁶ Beck, C. S., and Powers, J. H.: Burns Treated by Tannic Acid. *ANNALS OF SURGERY*, vol. lxxxiv, pp. 19-36, July, 1926.

- ⁷ Davidson, E. C., and Matthew, C. W.: Plasma Proteins in Cutaneous Burns. *Arch. Surg.*, vol. xv, pp. 265-274, August, 1927.
- ⁸ Cannon, W. B.: Traumatic Shock. D. Appleton & Co., p. 86, New York, 1923.
- ⁹ Pack, G. T.: Pathology of Burns. *Arch. Path. and Lab. Med.*, vol. i, pp. 767-805, May, 1926.
- ¹⁰ Pack, G. T., and Davis, A. H.: Burns. J. B. Lippincott Company, Philadelphia, 1930.
- ¹¹ Underhill, F. P.: Changes in Blood Concentration with Special Reference to the Treatment of Extensive Superficial Burns. *ANNALS OF SURGERY*, vol. lxxxvi, pp. 840-849, December, 1927.
- ¹² Underhill, F. P.: The Significance of Anhydremia in Extensive Superficial Burns. *Jour. Am. Med. Assn.*, vol. xcv, pp. 852-857, September 20, 1930.
- ¹³ Underhill, F. P., Kapsinow, R., and Fisk, M. E.: Studies on the Mechanism of Water Exchange in the Animal Organism; (1) The Nature and Effects of Superficial Burns. *Am. Jour. Physiol.*, vol. xcv, pp. 302-314, November, 1930.
- ¹⁴ Underhill, F. P., and Kapsinow, R.: Alleged Toxin of Burned Skin. *Jour. Lab. and Clin. Med.*, vol. xvi, pp. 823-830, April, 1931.
- ¹⁵ Curling, T. B.: Acute Ulceration of the Duodenum in Cases of Burn. *Med.-Chir. Trans.*, vol. xxv, p. 260, London, 1842.
- ¹⁶ Harris, R. I.: Fatal Burn; Death Due to Hæmorrhage into Suprarenal Capsule and to Hæmorrhage from Duodenal Ulcer. *Brit. Jour. Surg.*, vol. xvi, pp. 677-680, April, 1929.
- ¹⁷ Levin, J. J.: Duodenal Ulcers Following Burns; with Report of Two Cases. *Brit. Jour. Surg.*, vol. xvii, pp. 110-113, July, 1929.
- ¹⁸ Weiskotten, H. G.: Fatal Superficial Burns and the Suprarenals; Note on Occurrence of Suprarenal Lesions in Uncomplicated Fatal Cases of Extensive Superficial Burns. *Jour. Am. Med. Assn.*, vol. lxix, p. 776, September 8, 1917.
- ¹⁹ Cannon, W. B.: Traumatic Shock. D. Appleton & Co., p. 4, New York, 1923.
- ²⁰ Beard, J. W., and Blalock, A.: Experimental Shock; Composition of Fluid that Escapes from the Blood Stream after Mild Trauma to an Extremity, after Trauma to the Intestines and after Burns. *Arch. Surg.*, vol. xxii, pp. 617-625, April, 1931.

ARM-CHEST ADHESIONS AND THEIR PLASTIC RECONSTRUCTION

BY THE TUBE FLAP METHOD

BY JACOB KULOWSKI, M.D.

OF IOWA CITY, IOWA

FROM THE DEPARTMENT OF ORTHOPEDIC SURGERY OF THE STATE UNIVERSITY OF IOWA

THE object of this paper is to discuss arm-chest adhesions (brachiothoracic adhesions, axillary webs) in general, and to describe the reconstructive procedures used in a case herein reported. Axillary form and function were restored by the tube flap graft. The associated scar contractions were corrected by the Z-shift flap method.

Burns about the axilla, whether produced by the dry flame or scald, will often in the process of healing produce scarring and resultant binding of the arm to the side, thus preventing abduction at the shoulder. This complication is prone to develop in the axilla, and is definitely predicted by the normal resting arm-chest position, there being no tension stresses that would tend to minimize or prevent contraction, as in some parts of the body. However, this position is probably protective against more severe injury to the important vascular and nervous structures of the axilla. The final cicatrix will depend upon the extent, and depth of the injury, the presence or absence of infection, and the peculiarity of the tissue chemistry and physiology.

This serious disability may sometimes be avoided if preventative measures are persisted in during the period of healing, such as the continuance of full abduction at the shoulder by some form of splinting or traction, and the application of Thiersch grafts to the granulating area as soon as the bacteriology and the appearance of the wound permit.

However, prevention of deformity is not so simple a matter. The intrinsic contracture mechanism does not occur in the epithelium but in the subcutaneous connective tissues. Its exact mechanism is still undetermined. Where there is a distinct granulation tissue, the process of healing is an extremely complicated one, and there seems to be a transformation of the cells of the granulation into connective tissue. The early covering of raw surfaces with Thiersch grafts therefore acts chiefly as a protective layer which may certainly mitigate but not necessarily prevent recurrent contracture. The corollary to this is the plastic principle of excision of scar tissue wherever possible, and the restoration of the defects by the use of whole thickness type of grafts.

When the deformity is present the problem of restoring form and function is an urgent one. In no region of the body are the resultant mechanical deviations so injurious and far-reaching in their general effects from burn contracture. In no other anatomical situation is the restoration of form so

important in the realization of a good functional result. The axilla with the arm in abduction is a pyramidal space presenting a rather deep apex (armpit) and four walls. "The successful reconstruction, or readjusting of the axillary space, is the key to the relief of the condition." This normal hollow contour can be renewed only by the excision of the scar tissue and the recovery of the cutaneous surfaces by adequate normal skin.

Certain inevitable and far-reaching sequelæ of axillary burn contracture make adequate reconstruction imperative, whenever possible. The simplest of these is the inability, in some instances, to wear ordinary clothes. The bones of the shoulder girdle become atrophic and retarded from pressure of the scar and general disuse. Deformity of the ribs and limitation of thoracic excursion is present. Serious growth disturbances and scoliosis occur, particularly in children. Myogenetic and even myositic contractures may involve the axillary folds. Keloidal growths are not uncommon, and malignant degeneration has been observed.

The resultant web patterns vary from the thin lax membrane which allows considerable motion to the solid plug of scar which obliterates the axilla, and glues the arm to the chest. The thin web suggested the local shift flap methods of reconstruction about the middle of the last century.

Many local shift flap plastic reconstructive procedures have been devised with varying degrees of success in dealing with arm-chest adhesions. Several cases have been successfully treated by these procedures in this clinic. At first sight, these apparently simpler methods appear to be ideal, and certainly less laborious than the method to be outlined. Although no statistics shall be presented it may be stated that the experience of this clinic disproves this supposition. Some of these required as many as seven operations by several different procedures before the final result could be reckoned as satisfactory. It should also be remembered that most of the local shift flap technics were developed upon the observations of one or two cases. It may be axiomatically stated that there is no short road to the reconstruction of arm-chest adhesions. The greatest danger lies in trying to do too much at one sitting. The work must be done in stages.

The simplest treatment consists in division of the contracting bands, forcible, or better still gradual, abduction of the arm, and the immediate application of Thiersch grafts. This should be considered only when the web is a very thin one. "It is a good plastic principle to remove all scar tissue before attempting any sort of reconstruction." Simple division takes no cognizance of this primary principle, and recurrence is not obviated.

Other aforementioned methods employ the principle of shifting adjoining tissues after extensive undermining. Although these procedures are ingenious in their illustrative geometrically precise diagrams, they are, in actual practice, greatly limited in their execution by these definite qualifications: the thickness of the web, the firmness, depth and mobility of the scar tissue and its blood supply, and particularly the condition of the adjoining skin.

ARM-CHEST ADHESIONS

Extensive scar contractures therefore preclude such methods as those advocated by Defontaine, Piechaud, Berger, *et al.* Furthermore, extensive undermining of large flaps frequently leads to necrosis and subsequent infection which latter event may be even worse than the original condition. The tendency to maceration of the shifted flaps, even after apparent healing, has been observed in several cases treated by these technics in this clinic.

Garlock states that the free full thickness graft cannot be applicable because of the uneven contour of the axilla. The writer has had an oppor-



FIG. 1.



FIG. 2.

FIGS. 1 and 2.—Adhesion following burn contracture.

tunity to examine several excellent results obtained by Blair, by his split skin method, at the Shriner's Hospital in St. Louis, Missouri. This procedure merits serious consideration.

Fortunately, dermogenetic contractures yield in part to gradual correction as do many of the myogenetic variety. This preliminary conservative measure should always be instituted before any operative plans are made. This same principle applies also to the post-operative period of treatment. Steindler states that after reconstruction it is not necessary for the arm to assume the extreme position of correction at once. The tension of the new-

formed flap demands that such a position of full abduction be attained gradually and in steps. The other, most important of all, measures preliminary to operation include the building up of the general condition of the patient and the local improvement of the skin by massage.

The arm-chest adhesion reconstruction in the case to be reported was done in stages and consisted essentially of the transference of a skin flap from a distance with the maintenance of its blood supply, temporarily, through a tube flap which was in turn utilized in the reconstructive process. Although skin plastic surgery goes back to antiquity, no one seems certain who first advocated the tube flap, but Gillies, of London, is credited with its development during the war.

CASE.—The patient, Cecily Ann S., aged four years, was admitted to the hospital October 7, 1931, on account of arm-chest adhesions the result of burns sustained when clothing ignited accidentally while playing with matches in May, 1931. Was treated by the application of ointments. No splints. Healing with contracture in four months. Condition is shown in Figs. 1 and 2. Scoliosis and a moderate flexion contracture of the right hip also present. Due to skin irritation, the preliminary mechanical stretching, after admission to the hospital, had to be discontinued after one week. The steps employed for her operative reconstruction were as follows:

(1) November 19, 1931.—A single longitudinal tube flap was fashioned on the chest wall posteriorly as close to the axilla as the scar would permit (Fig. 3), which included the skin and subcutaneous tissues. The length of the tube flap is so planned by measurement that its distal end may later be transported to its final bed just under the lower border of the cicatricial web, and consist of sufficient skin to complete the restoration of the axilla. Healing was uneventful except for several temporary stitch abscesses which occurred chiefly on the chest wall.

(2) December 9, 1931.—A rectangular flap, with rounded corners, of skin and subcutaneous tissue continuous with distal pedicle was completely dissected away from the underlying fascia. This was then replaced, after careful hemostasis, and the skin edges approximated with interrupted dermal sutures. The purpose of this procedure is to permit the formation of new blood-vessels through the proximal pedicle before the complete severance of the distal end from the chest wall. (Fig. 4.) Healing was uneventful. An intercurrent respiratory infection now caused some delay in the treatment.

(3) January 8, 1932.—A portion of the scar was excised just below the web of the axilla to receive the distal end of the flap. (By leaving the web intact, at this stage, post-operative splinting is obviated.) The original temporarily raised (B) flap was now excised and transported to its position below the web. The proximal pedicle remained undisturbed. (Fig. 5.) The flap was then carefully approximated, after all dead space was obliterated by fine catgut sutures uniting the subcutaneous tissues of the flap to the chest wall.

Due to the area of the distal flap and because of retraction, a considerable defect resulted. This could not be entirely obliterated even after the employment of extensive relaxation incisions. The residual small central gap was allowed to granulate in.

Examination after five days revealed apparent necrosis of the distal half of the transported flap, although the tube itself remained normal. There was evidence of fluid accumulation under the flap and some serous discharge. This was gently drained dependently. Four days later a moderate retraction of the bed scar edges was present. But the flap itself was apparently in better condition and remained attached. Moist dressings were continued. One week later only the distal one-fourth of the flap was actually necrotic, and this was now resected. A moderate amount of drainage persisted

ARM-CHEST ADHESIONS



Fig. 3.



Fig. 4.

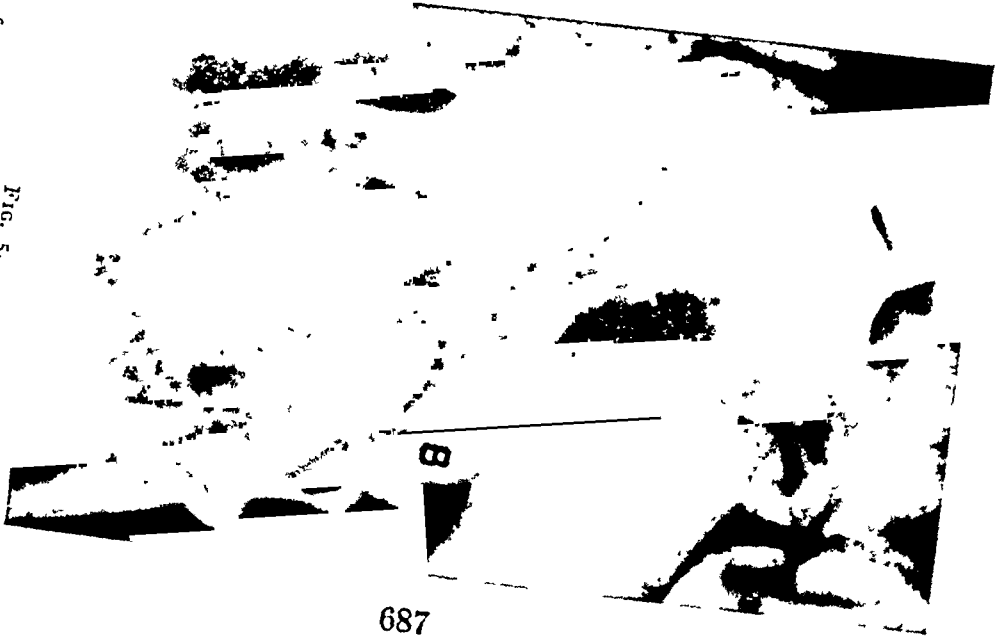


Fig. 5.

Fig. 3.—The tube flap two weeks after its preparation. It was ten inches long, and the parallel incisions of the shank were three inches apart. The pedicles were planned broader to insure a good blood supply. Moderate necrosis occurred only at the proximal axillary angle where the flap bordered the scar.

Fig. 4.—Two weeks after the temporary dissection of the distal rectangular flap.

Fig. 5.—This flap (B) has been lifted and transported to its bed just below the web.

for some length of time but finally cleared up after local and general ultra-violet irradiation.

(4) April 12, 1932.—The proximal pedicle was freed. Definite bleeding from the tube flap was noted. The tube was opened along the line of closure. There was only a moderate amount of shrinkage and fibrosis of its subcutaneous structures, and the flap was sufficient to cover the axillary defect. All the dense mass of scar tissue in the axilla and the web was excised and the arm was easily abducted to ninety degrees. The remainder of the flap was transported to the axilla. Careful hemostasis and obliteration of all dead space followed. Chromic stay sutures were taken in the subcutaneous



FIG. 6.



FIG. 7.

FIGS. 6 and 7.—Showing amount of abduction of the arm obtained by the transplantation of the tube flap thirty-six days after the final transportation of the entire tube flap. The scoliosis has not been correctively influenced.

and deeper structures of the axillary folds to prevent subsequent retraction. The shoulder and arm were then firmly immobilized to the chest wall in about forty-five degrees abduction to prevent excessive tension upon the flap. Healing of the graft was uneventful. (Figs. 6 and 7.) After complete healing, full abduction of the arm was obtained by gradual correction with a turnbuckle abduction splint.

(5) September 6, 1932.—The scoliosis and the flexion contracture of the groin required further operative interference, and correction was accomplished by the Z-method. This technic is particularly indicated in contractures where it is impossible to resect the scar, and was first described by Denonvilliers, in 1856. (Davis.) By this method flaps of scar-infiltrated tissue are utilized. To do this some manœuvre must be carried

ARM-CHEST ADHESIONS

out which will relax the contracted band and break the line of scar tension. The transportation of flaps thus formed is made possible because there is always shortening of the tissues in the direction of the contraction and usually excess or fullness on both sides of the contracted band. It is most applicable in contractures which present a prominent bridle or web; but it can also be utilized in those contractures less commonly characterized by a groove. (Fig. 1 plainly shows a bridle in the right groin. The ridge along the right flank was utilized as a bridle in that situation.)

The technic of the incisions outlines a Z or a reverse Z, and the resultant flaps are interchanged, thus lengthening the area of the scar. The longest line of the Z is made along the prominence or in the middle of the groove, if the latter is present. The arms begin at each end of the central incision on opposite sides with their angles as seems



FIG. 8.

FIG. 9.

FIG. 10.

Figs. 8, 9 and 10.—Result six months after the complete reconstruction of the axilla, and one month after the Z-shift flap correction of the right groin and flank.

necessary. The two triangular resultant flaps are then undercut, mobilized, transported and their tips sutured into the opposite angles formed at the outer ends of the arms. The irregular wound is closed and dressed.

In this case these procedures gave excellent results. (Figs. 8, 9, and 10.) The flaps over the flank were quite extensive and permitted correction of the scoliosis immediately following the shifting of the flaps. Healing was uneventful.

Comment.—It is necessary to emphasize certain factors which have been omitted in the description of the procedure for the sake of clarity.

The operator should become familiar with the "lines of the skin" which indicate where the skin tension is greatest, and will serve as a guide to the proper placing of incisions, and their direction and extent with a view to providing minimum subsequent scarring. Due to the transverse direction of the normal skin tension field upon the back, there resulted considerable retraction of the skin edges following the formation of the tube. This gap

was approximated without undue difficulty after the establishment of liberal plastic relaxation incisions. It is evident that a transverse tube, even though it would necessitate its complete subsequent torsion, should minimize the tendency to separation. The size of the secondary distal flap should be accurately gaged, and will depend upon the mobility of the skin at the elective site. In this case considerable difficulty was experienced in attempting to close the defect following the removal and transportation of this rectangular flap, in spite of the fact that the final excision was only two-thirds of the original area mapped out.

The viability of an unusually long flap, when this is necessary, may be further insured by temporarily interrupting the parallel incisions, thus forming a somewhat linked tube. The interrupted portions may be united to form one tube after the blood supply has been established. The longevity of this primary tube is demonstrated in this case. Arm-chest adhesions require rehabilitation in several stages. One may depend upon the continuance of the flap's viability should unforeseen circumstances cause considerable delay between operative stages.

Sharp borders should be sedulously avoided in skin grafts because of their tendency to necrosis. Instead of the rectangular flap, as used in this case, it is far better to plan the so-called "frying pan" type of flap. Had this precaution been accurately observed, the disconcerting partial necrosis following the transportation of this distal flap would have been in great part minimized.

Following the excision of scar and its cutaneous surface, there is a great tendency to retraction of the defect margins which may exert harmful tension upon the graft or even spread beyond the area of the graft. The cutaneous surface over a scar area is often histologically undifferentiated from normal skin. (There is usually a loss of the papillæ elastic fibers.) It is wise in preparing a bed for the graft, in the region of the axilla, to incise (not vertically) and allow retraction of the skin border after the subcutaneous connective tissue has been excised. The more skin available the better the functional result, particularly in extensive scarring, where the formation of the tube has added to the general constriction about the chest. Excessive retraction is to be especially guarded against in the armpit proper. The skin edges must be securely stitched to the deep structures of the axillary folds with chromic sutures. Retraction will follow as a regular consequence but the normal elasticity of the graft will accommodate itself to this after healing has taken place and the graft has taken.

Injury to the important vascular and nervous structures of the axilla must be avoided in the excision of the scar plug from the armpit. The dissection will usually prove to be more extensive than is apparent at the outset. Distortion of the normal landmarks accompanies severe scar contractures in this region. Accidents may be prevented if one remembers that the vascular

sheath and its accompanying nerve trunks are on the humeral wall of the axilla.

Infection is the commonest complication of plastic surgery and one of the most dreaded. The most rigid aseptic technic must be observed, and entails a meticulous pre-operative preparation of the skin. In this clinic all plastic cases receive the same careful forty-eight-hour preparation that is routinely observed for all orthopædic conditions. Absolute hemostasis is essential before application of the graft. When infection occurs, they usually yield to mild antiseptic moist dressings, and particularly to local and general ultra-violet irradiation. The importance of building up the general condition of the patient after infection occurs was clearly demonstrated in this case by her response to general hygienic measures and blood transfusions.

All skin closures were made with interrupted dermal sutures. It is quite possible that stitch abscesses are less likely to follow the use of horse hair, but in this type of grafting the tension of the operative fields demands stronger material. Fine (oo) catgut was used for the subcutaneous tissues to obliterate dead spaces, and wherever the tension indicated it.

Even-pressure vaseline gauze dressings were always applied upon the fresh post-operative fields, care being especially exercised to prevent any pressure upon the tube portion of the flap. The dressings need not be disturbed for about five days. Just as soon as the macerating effects of the vaseline are evident, dry dressings may be substituted, particularly after there is definite taking of the graft.

BIBLIOGRAPHY

- Steindler, A.: A Text-book of Operative Orthopedics. D. Appleton & Co., 1925.
Idem: Reconstructive Surgery of the Upper Extremity. D. Appleton & Co., 1923.
Idem: Skin Flap Methods in the Upper Extremity. Jour. Bone and Joint Surg., vol. vii, No. 3, pp. 512-527, July, 1925.
 Davis, John Staige: The Relaxation of Scar Contractures by Means of the Z, or Reversed Z-type Incision. ANNALS OF SURGERY, November, 1931.
Idem: Plastic Surgery, P. Blakiston's Son & Co., 1919.
Idem: The Principles of Plaster Surgery. Practice of Surgery, Dean Lewis, vol. v, p. 108, Ch. 8, 1930.
Idem: Arm-Chest Adhesions. Arch. Surg., vol. viii, pp. 1-23, January, 1924.
Idem: The Use of the Pedunculated Flap in Plastic Surgery. ANNALS OF SURGERY, vol. lxviii, pp. 221-230.
 Blair, Vilray P.: The Use and Uses of Large Split Skin Grafts of Intermediate Thickness. Surg., Gynec., and Obst., pp. 82-97, July, 1929.
Idem: The Delayed Transfer of Long Pedicle Flaps in Plastic Surgery. Surg., Gynec., and Obst., vol. xxxiii, pp. 261-272.
 Berger, P., and Bonset, S.: Traitments de deformations consecutives aux cicatrices vicieuses de l'épaule. Chir. Orthop., p. 180, Paris, 1904.
 Denonvilliers: Blepharoplastie. Bull. Seco. de Chir. de Paris, vol. vii, p. 243, 1856-1857.
 Picchaud, T.: Deux observations de symphyse des membres a la suite de brulures étendues. Rev. d'orthop., vol. vii, p. 81, March, 1896.
 Reverdin: Bull. de la Soc. de Imp. Chir., p. 493, 1869.
 Thiersch: Arch. f. klin. Chir., vol. xvii, p. 318, 1874.
 Wolfe: Brit. Med. Jour., September 18, 1875.

JACOB KULOWSKI

- Krause: Arch. f. klin. Chir., vol. xlv, p. 177, 1893.
- Ollier, P.: Bull. Acad. de Med., vol. ii, p. 244, 1872.
- Tagliacozzi, G.: De Curtorum Chir. per insitionem, 1597.
- Harsley, J. S.: Causes of Cicatricial Contraction. ANNALS OF SURGERY, vol. lxxxiv, pp. 185-202, August, 1926.
- Jones, H. T.: Contracture of Axilla from Burns. Minn. Med., vol. xi, pp. 210-214, April, 1928.
- Garlock, John H.: A Method of Reconstruction of Axilla for Contracture. Surg., Gynec., and Obst., vol. li, pp. 705-710, November, 1930.
- Idem*: Prevention of Cicatricial Contractions. Am. Jour. Surg., vol. viii, pp. 344-345, February, 1930.
- Beckman, F.: Prevention and Treatment of Contractures Following Cutaneous Burns. Am. Jour. Surg., vol. vi, pp. 810-811, June, 1929.
- Videman, G. T.: Plastic Surgery of Cicatricial Contractures of Underarm. Vestnikhir (Nos. 56-57), vol. xix, pp. 323-328, 1930.
- Treves, N., and Pack, G. T.: Development of Carcinoma in Burn Scars. Surg., Gynec., and Obst., vol. li, pp. 749-787, December, 1930.
- Pack, G. T.: The Pathology of Burns. Arch. Path., vol. i, No. 5, pp. 767-805, May, 1926.

ARTIFICIAL INGUINAL HERNIA *

BY ESKE HARRY WINDSBERG, M.D.

OF PROVIDENCE, R. I.

AN ARTIFICIAL inguinal hernia is a hernia of the inguinal region that is deliberately produced. It is seen almost exclusively in wilful evaders of military service. Its formation involves a definite method of procedure which will be explained. The Russian literature is replete with writings on the subject. There are also several excellent articles in the German literature, and one or two in the Roumanian. In this country, A. G. Gerster,¹ A. V. Moschcowitz,² W. B. Coley,³ and Parker Symms,⁴ have made mention of the condition.

Artificial inguinal hernia has up to the present time been noted exclusively among Russians. Cases observed in this country had all been produced in Czarist Russia. There military service was long, compulsory, and entailed hardships unknown to the soldier of any other nation. Military service was particularly dreaded by Russian Jews; due to anti-Semitic feeling they were severely maltreated, and had to endure great mental and physical anguish. It is not surprising, therefore, that most artificial hernias have been found among Jews.

Inguinal hernia is only one of the many artificially produced ailments to which human ingenuity has turned in order to evade military service. Thus we find artificially produced phlegmons, granulomas, parafinomata, contractions, rectal prolapses, rectal fistulæ, and cystitis.⁵ Artificial inguinal hernia is probably the most common of these conditions and lends itself most readily to identification as being of artificial etiology.

Artificial inguinal hernia, though somewhat of a curiosity in this country, is most interesting from an anatomical point of view. Furthermore, a thorough study of the subject gives one an excellent insight into the causation of direct inguinal hernia, and helps one to define the principles underlying a rational cure of direct inguinal hernia.

Definition.—For want of anything better, Moschcowitz⁶ has introduced into the English literature the term "artificial inguinal hernia," to differentiate a type of inguinal hernia from natural and so-called traumatic inguinal hernia. Da Costa⁷ employs the term "self-produced traumatic hernia." In the German literature are found the captions "artifizielle und Kunstliche Leistenbrüche." This implies not only that the hernias are artificial, but also that they are made by a person adept at producing such hernias. Most persons state that they employed a "felscher" to have the hernia produced. "Felscher" is a Russian term synonymous with our "orderly."

* Thesis submitted to the University of Pennsylvania for the degree of Master of Medical Science [M.Sc.(Med.)] for graduate work in Surgery.

Historical.—In 1866, Sanizky⁸ and Monkewitz⁹ independently described atypical forms of inguinal hernia among Russian recruits. Their descriptions indicate that they were dealing with cases of artificial inguinal hernia although they were unaware of that fact. In 1888 and 1890, Orlov¹⁰ recognized and described cases of artificial inguinal hernia: "A type of hernia occurring in young men of military age, hitherto never seen." It was his belief that they occurred only in Jews, and only on the left side. In the light of subsequent observations, both contentions were erroneous. Wroblewsky,¹¹ in 1891, reported eight cases which he had observed. In the same year, at the Tenth International Medical Congress held at Berlin, Bornhaupt¹² presented an undoubted case which had come under his observation at the Military Hospital at Kief. Even then the possibility that an inguinal hernia could be produced artificially did not meet with general acceptance.

In 1893, Schulz¹³ was able to collect from the literature 133 cases of artificial hernia. All were direct; 121 were right-sided and only twelve left-sided. In 1894, Ignatow¹⁴ reported twenty-two cases and Crasnoff¹⁵ described eight cases that came to operation. Many other reports are presented in the Russian literature but up to 1899 no clinical differentiation was attempted. It was only in those instances in which the patient volunteered the information that an artificial etiology could be assumed definitely. Furthermore, surgeons did not believe that a person in good physical condition could sustain sufficient damage to the deep layers of the abdominal wall without narcosis to cause a hernia.

Etiology.—The production of an artificial inguinal hernia involves a definite method of procedure as practised by a "felscher." The patient is usually taken to an isolated field so that any outcry he may make will not attract attention. No anaesthesia is employed as a rule; in rare instances a little chloroform is used. The voluntary victim is placed on his back. While an assistant guards the upper extremities, the "operator" kneels astride the knees and thighs. The "operator" then invaginates the scrotum with the forefinger, and palpates the superficial inguinal ring. If only large enough to admit the tip of the finger, the ring is first torn. The forefinger is then plunged past the superficial ring mesially, downward and backward with sufficient force to overcome all resisting tissues. This involves a tearing of the posterior wall of the inguinal canal, namely, the transversalis fascia, a rather painful procedure for the patient. When the properitoneal fat and peritoneum are reached all resistance is overcome. Tearing of the peritoneum is almost impossible because of its laxity in this part of the inguinal region.

The foregoing manipulations having been completed, the patient is advised to take snuff liberally in order to produce sneezing. He is also ordered to exercise violently. In due time, ranging from several days to several months, a hernia becomes manifest. Sometimes a hernia does not develop even though the "felscher" has done his work perfectly. The reason for this will become apparent. The hernia produced is always of the direct variety. It presents at the mesial part of Hesselbach's triangle just lateral to the edge of the rectus and above the spine of the pubis. Although usually on the left side, these hernias are also seen on the right side, and may be bilateral.

Experimental.—The investigations of Galin,¹⁶ in 1899, dispelled all the controversial points surrounding the subject of artificial inguinal hernia; he

conducted many experiments on the cadaver and also added several clinical observations. He showed that experiments carried out by workers before him were fruitless because they failed to tear the tissues deep to the superficial inguinal ring. In 1908, Krymow¹⁷ repeated Galin's experiments, and added greatly to our knowledge of the subject.

Tearing of the subcutaneous inguinal ring, and splitting of the external oblique aponeurosis above the ring do not suffice to create conditions favorable for the formation of a hernia. For a hernia to develop under the foregoing circumstances the presence of a preformed sac must be assumed. In the absence of such a sac the transversalis fascia on the mesial aspect of the inguinal canal, corresponding to the fovea inguinalis medialis, must first be torn as this is the point where artificial hernias invariably present themselves. Then, and not until then, will a hernia be produced.

Galin produced hernias in the cadaver in the following manner: After invaginating the scrotum with the forefinger or a similarly shaped instrument, the intercolumnar fascia covering the superficial ring was torn. When the ring did not admit the tip of the finger or of the instrument employed, it was impossible to tear the ring directly. Any force exerted here tore the aponeurosis in the direction of its fibres above the ring, usually leaving the latter intact. But when the tip of the finger could enter the ring it was easily torn, the tear extending upward and outward in the direction of the fibres of the external oblique aponeurosis. The pillars of the ring did not tear away from their points of attachment.

Having passed the subcutaneous inguinal ring, Galin, in one group of cadavers, directed the force to the mesial side of the cord structures. If a fibrous layer covered Hesselbach's triangle it tore under the strain. If muscle covered the triangle the fibres separated without tearing. The transversalis fascia was now reached and torn; whereupon the finger or instrument met with no further resistance. In another group of cadavers Galin directed the force upward and laterally along the inguinal canal with the idea of reaching and tearing the abdominal inguinal ring. In these instances the cremaster muscle was torn either at the subcutaneous ring or within the canal. The finger was directed above and lateral to the inferior epigastric artery; Galin's aim was to attempt a production of an indirect inguinal hernia.

Following the aforementioned manipulations pressure was exerted periodically upon the abdomen from the front and sides. In some instances the intra-abdominal pressure was raised by injecting water per rectum against a tied-off œsophagus. Finally, in some cases, a mixture of hot water and plaster-of-Paris was injected intraperitoneally. In this manner casts of the peritoneal indentations and their relationships to the structures of the inguinal region were obtained. The type of hernia produced could thus be ascertained. Final deductions, however, were based for the most part on carefully conducted dissections.

When the force was directed mesially and backward, internal to the epigastric artery, a direct hernia was always produced. Galin found that it was well formed and that it always presented at the middle inguinal fossa (fovea inguinalis medialis) corresponding to Hesselbach's triangle. When the force was directed lateral to the inferior epigastric artery and the transversalis fascia in the neighborhood of the abdominal inguinal ring was torn, Galin found that only a small protrusion of the peritoneum occurred. This protrusion appeared not at the place where the fascia was torn, but at a point lower down, again in the neighborhood of the middle inguinal fossa. The peritoneal bulge here was small and wrinkled, and the hernia was not well formed due to the obstructing influence of the transversalis fascia which had not been divided in the lower half of the inguinal canal.

Here, too, Galin obtained a direct hernia in spite of the fact that he had attempted to produce one of the indirect variety. The hernial tract, however, was oblique and not perpendicular to the plane of the abdominal wall. Such a hernia was placed nearer to the abdominal inguinal ring, and its poorly developed sac covered the cord mesially and anteriorly. It thus gave Galin the impression of being an oblique hernia; but careful dissection and plaster-of-Paris impressions demonstrated that the bulge was medial to the inferior epigastric artery.

In the absence of a preformed sac it is only at the fovea inguinalis medialis that sufficient displacement and thinning out of the peritoneum occur to favor the development of a hernia. Upon this basis Galin explains the invariable finding of the direct variety both in artificial inguinal hernias and in inguinal hernias produced experimentally in cadavers.

The experiments and observations of Krymow¹⁷ are of interest here. He tore the abdominal wall with a finger which, with the invaginated scrotum, was pushed up into the inguinal canal. The cadaver was then placed in the upright position. In some instances a hernia was immediately discernible. In others, besides the upright position, it was necessary to press on the abdomen before a hernia was noted. In a few, in spite of all the manipulations, careful dissections failed to disclose a hernia. Krymow explained the above findings on the basis of normal variations in the anatomical configuration of the inguinal region. Abdominal walls may be classified as being strong, of medium strength, or weak, according to the development of the muscular, fascial, and aponeurotic planes. The aponeurosis of the external oblique presents variations in thickness and uniformity, and in the absence or presence of defects in its structure. There are also variations in the size and shape of the subcutaneous inguinal ring. It may be triangular, oval, or round.

Krymow investigated fifty male cadavers (100 inguinal regions) and found variations in the shape and size of the inguinal interspace. This is the area lying between the lowermost fibres of the internal oblique and transversalis muscles above, Poupart's ligament below, and the edge of the rectus muscle medially. Forty-six of the interspaces presented a slit-like formation and the lowermost muscle fibres ran almost parallel to Poupart's ligament. In thirty-four instances the area was elliptical and in the remaining twenty it was triangular. In the triangular form the lowermost fibres of the internal oblique and transversalis muscles ran horizontally over to the edge of the rectus. Krymow found that in instances in which the interspace presents a large triangular formation, all other things being equal, the defense against hernia formation will be the weakest; on the other hand, when the interspace is slit-like, the defense will be the strongest.

Finally, Krymow found that the transversalis fascia is not of uniform strength throughout and presents also great individual variations. Along the edge of the rectus muscle the fascia is reinforced by the tendinous band of Heule, through which it receives attachment to the spine of the pubis. At the medial edge of the deep inguinal ring the fascia is reinforced by strong arcuate fibres known as the ligament of Hesselbach. The nearer the fascia approaches Poupart's ligament to become continuous with it, medial to the deep inguinal ring, the stronger its fibres become. This is true also of the lateral expanse of the fascia as it approaches the strong iliac fascia with which it becomes continuous. It is important to note that the weakest part of the transversalis fascia in the inguinal region is placed at the fovea inguinalis medialis, where practically all natural direct hernias and all artificial hernias occur.

Krymow dissected the inguinal regions of the cadavers upon which he had attempted to produce hernias experimentally. The tear in the aponeurosis of the external oblique always followed the line of its fibres. The pillars of the subcutaneous inguinal ring were apparently never torn. Nor did the transversalis fascia always tear; if loose it tore easily, if taut it stretched under the pressure of the finger without tearing. In the latter instance a strong blow in the form of a thrust was necessary to tear the fascia; and

even then it was not always torn, or else the peritoneum tore together with it. Krymow also noted that when the muscular layer was especially well developed a hernia did not ensue even though the external oblique aponeurosis and the transversalis fascia were torn. On the other hand, when the muscular layer was defective a hernia developed after an injury to one fascial plane, but only in the event that the other was congenitally weak. When the muscular layer was defective, and the external oblique aponeurosis poorly developed, with a wide inguinal ring, very little pressure, lasting from thirty to forty minutes, was required to thin out the transversalis fascia and cause a hernia to form. On dissection, in these instances, no gross evidence of a trauma could be discerned. Finally, in order to tear all of the layers of a strongly built inguinal region great force was required; and in such instances very frequently the peritoneum also was torn, resulting not in hernia but in a prolapse. This was especially true in cases presenting a very narrow subcutaneous inguinal ring with a soft and relaxed abdominal wall. When the abdominal wall was taut and distended much less force was required to bring about a prolapse.

Pathological Anatomy.—Our knowledge of the anatomical alterations and pathological changes occurring in artificially produced inguinal hernia is based essentially upon the findings noted by surgeons at operation. Some of the facts have been clarified by experiments on the still warm cadaver.

As noted heretofore, the degree of force necessary to produce an artificial hernia depends upon the strength of the anatomical components of the inguinal region. In instances in which all the layers of the inguinal region are poorly developed, with wide subcutaneous rings and triangular inguinal interspaces, very little pressure is required to thin out the transversalis fascia. So little force may be called for in these cases to create conditions favorable for a hernia to develop that at operation no evidence at all may be present to indicate that one is dealing with other than an ordinary direct hernia. On the other hand, in cases with strong inguinal regions the anatomical and pathological alterations are extensive and distinct.

Artificial hernias that come to the surgeon's attention early will be considered under diagnosis. Those that come to the operation long after they have been produced will be here considered, remembering that we are dealing with instances in which the trauma entailed must have been appreciable.

(a) *Anatomical Alterations.*—The subcutaneous inguinal ring is almost always injured and altered, and presents a triangular appearance. The tear in the ring extends upward and outward, parallel with the fibres of the external oblique aponeurosis. Occasionally the ring is found to be intact, and in such instances an abnormal opening in the aponeurosis is found just above the ring. This abnormal opening presents notched, ragged, and scalloped edges which are pathognomonic of a direct trauma. In the posterior wall of the inguinal canal there is found an abnormal opening which is placed in juxtaposition to the torn or naturally enlarged superficial ring, or to the tear in the aponeurosis of the external oblique above the ring. This abnormal opening consists of a hole in the transversalis fascia and surrounds the neck of the hernia. The tear is always found at the fovea inguinalis medialis. It is oval and admits from two to four fingers.

Frequently no trace is found of an inguinal canal. The cord structures are often separated from one another. The vas is firmly adherent to the sac and lies on its lateral aspect. The hernial mass appears as a bulge about the size and shape of half a chicken's egg cut longitudinally. Thus the neck of the hernia is wider than any part of the hernial bulge.

(b) *Pathological Characteristics*.—In artificial inguinal hernia pathological alterations are found which are due to extensive adhesions and fibrosis, and which are out of proportion to the small size of the hernia. The distortions, adhesions, and thick fibrous tissue encountered are comparable to those often found in a recurrent hernia. The impression one gets is that all the tissues and structures have been glued together. The superficial fascia is adherent to the subcutaneous inguinal ring. The crura of the ring are thickened and the superior crus is firmly adherent to the anterior surface and lateral edge of the rectus muscle. Normally this crus can be folded upward away from the underlying muscle when the inguinal canal has been opened. The cord is firmly fixed by fibrous tissue to the edges of the subcutaneous ring and can be freed from the canal and from the sac of the hernia only with the greatest difficulty. The transversalis fascia is strongly adherent to the peritoneum of the sac.

It is obvious, therefore, that in cases in which only the transversalis fascia has been torn the pathological signs may be trifling. Such instances are rare. In other cases, however, in which the trauma has been severe, the pathological changes are extreme and readily attract the attention of the operator. Between these two extremes the degrees of trauma inflicted and the resulting pictures of pathological anatomy are many and varied. Ordinarily sufficiently distinctive alterations are present to enable one to differentiate artificial inguinal hernia from the usual direct inguinal hernia.

Diagnosis.—The diagnosis of artificial inguinal hernia, in the absence of a reliable history, is based not on any single pathognomonic characteristic, but on the general picture of the condition. The surgeon who possesses knowledge of this type of hernia should have no difficulty in recognizing it. Although the diagnosis may be made upon physical examination, it can surely be done during the operation.

In the upright posture the patient presents a swelling just lateral to the edge of the rectus muscle in Hesselbach's triangle. The hernial mass usually shows no tendency to gravitate into the scrotum and on reclining it usually disappears spontaneously. Rarely, artificial hernias may become very large and even scrotal. Moschcowitz, who has operated upon many of these hernias, has never seen one that had descended into the scrotum. An artificial hernia is always a direct hernia. The only suggestion that it may be oblique has come from Solomka¹⁸ who reported eight such cases. This view is remarkable in that these eight cases comprise his entire series and is contradicted by all the experimental and clinical evidence at hand. It is my belief that an oblique artificial hernia represents an instance in which a preformed sac was present. The unobliterated processus vaginalis offers

ARTIFICIAL INGUINAL HERNIA

less resistance to the development of a hernia than does the artificially created defect at the middle inguinal fossa.

In recent cases examination reveals swelling, hæmatoma, tenderness, and ecchymosis. But by the time the hernia is fully formed and the patient presents himself to the physician, most of these signs are gone. The subcutaneous inguinal ring is examined by invaginating the scrotum with the finger in the usual manner. The crura of the ring are felt to be distinctly thickened—a condition which never obtains in the usual type of hernia. The superior crus of the ring cannot be lifted away from the underlying edge of the rectus muscle as is usually the rule. This thickening of the crura and fixation of the superior crus are believed by most writers on the subject to be the most dependable and most characteristic signs obtainable by physical examination. In every case which has come under my observation these signs have always been present and were readily discernible. Although probably not absolutely pathognomonic these findings are sufficiently characteristic to arouse the surgeon's suspicions and lead him to look for further evidences of artificial inguinal hernia.

These further evidences are discernible at the time of operation. As has already been noted, the pathological changes encountered are sufficiently distinctive to lead one to make the diagnosis even though the patient has been inadequately examined prior to operation. In early cases one finds signs of recent infiltration within and in the neighborhood of the inguinal canal and of the subcutaneous inguinal ring. In very early cases hæmatomata and ecchymoses may be seen. The characteristic pathology encountered in late cases has already been discussed. The operator is readily impressed by the obscured anatomical relationships, the firm adhesions throughout, and the fibrosis which has effected a generalized union of all the structures dealt with. He very soon realizes that he is dealing with something differing from the usual direct hernia. Dr. Leon Ginzburg,¹⁹ adjunct surgeon at the Mount Sinai Hospital, had his suspicions aroused on two separate occasions while operating because he encountered such conditions. During convalescence close questioning elicited, in each instance, a history of artificially produced inguinal hernia.

Artificial inguinal hernia must be differentiated from true traumatic hernia of the inguinal region. So-called traumatic hernia need not be considered here. The traumatic hernia referred to is the direct accidental hernia resulting from an injury by a blunt instrument. It is not my intention to enter into a thorough discussion of the possible similarities and obvious differences between the two conditions; it suffices to state the following: (a) In rare instances only can a true traumatic hernia simulate an artificial inguinal hernia. The skin must remain unbroken, and the trauma must have occurred directly over the subcutaneous ring or just above it. (b) Usually, in traumatic hernia the injury occurs above or lateral to the ring, leaving it intact. The opposite obtains in artificial inguinal hernia.

Treatment.—The operative procedure to be employed in the radical cure of artificial inguinal hernia is in its essential feature clearly apparent to the surgeon who encounters one of these cases. This feature involves a recognition of the tear in the transversalis fascia, and the repair of the defect. The fascia in these cases is usually well defined, and affords an excellent tissue for the repair. It is not lax and thinned out over the hernial bulge as is the case in the usual direct hernia.

In clearing the structures of the inguinal region preliminary to the repair, careful, sharp dissection should be employed in order to avoid injury to the components of the cord. With a little patience the fascial planes can be cleared without creating operative defects, especially in the aponeurosis of the external oblique and in the peritoneum. The transversalis fascia, as it forms a collar about the neck of the hernial sac, is carefully dissected away and is then mobilized from the underlying peritoneum and properitoneal fat for about a half inch all around. In some cases the peritoneum need not be opened. The transversalis fascia is sutured over the hernial bulge. This fascia may be imbricated, or the edges may be brought together and then another row of sutures placed so as to infold the first row. When dealing with a lax fascia, a third row of stitches should be taken; the needle here practically always encounters firm transversalis fascia.

The final features of the repair need no special mention here since they are the same as those employed in the handling of any direct inguinal hernia. Moschcowitz²⁰ effects a purely fascial and aponeurotic repair and avoids the inclusion of muscle in his cardinal sutures. The aponeurosis of the external oblique is imbricated. The upper flap is sutured to the shelving edge of Poupart's ligament behind the cord, thus buttressing the repaired part of the transversalis fascia with nothing intervening between the fascia and the aponeurosis. The lower flap is sutured over the cord, creating for it an aponeurotic canal.

CASE REPORTS.—My interest in the subject of artificial inguinal hernia began in November, 1929, when I had the opportunity to observe a case in the care of Dr. A. V. Moschcowitz. While preparing this thesis I have been on the lookout for similar cases and have been able to find two more. One of these cases was bilateral. Thus the writer has personally observed four instances of the condition. A casual search of the records of Mount Sinai Hospital revealed only two further cases. Doctor Moschcowitz, however, recalls that he has operated on quite a number of patients, approximately fifteen, in former years before emigration from Russia was restricted. Dr. Leon Ginzburg operated on one patient in 1925, and on another in 1926; the records of these two cases were located through his courtesy.

CASE I.—S. G., twenty-eight years of age, born in Russia, admitted January 2, 1922, to Mount Sinai Hospital for left inguinal hernia, on the Surgical Service of Dr. Howard Lilienthal. He stated that the rupture was produced in 1915 in order to avoid military service; a left direct hernia with a defect in the abdominal wall, just lateral to the rectus muscle, about 3 centimetres in diameter. Edges of transversalis fascia palpable. The

ARTIFICIAL INGUINAL HERNIA

superficial inguinal ring on the right side was enlarged but no hernia was present. Operation by Dr. Harold Neuhof; very extensive adhesions found; the defect in the transversalis fascia measured 7 by 7 centimetres. Poupart's ligament in its mesial aspect could barely be identified from the surrounding cicatricial tissue. The dense scar tissue was dissected away from the sac; during the manipulation the vas was accidentally cut across. The deep epigastric vessels had to be cut and ligated. The sac was opened, the excess ablated, and closed with a continuous chromic suture. The internal oblique and transversalis muscles were isolated from the scar tissue and sutured to Poupart's ligament with kangaroo tendon. The external oblique aponeurosis was imbricated behind the cord.

CASE II.—J. G., forty-six years of age, born in Russia, was admitted October 23, 1922, to the Surgical Service of Dr. Edwin Beer, complaining of a hernia on the left side. He admitted that the rupture was induced by a "felscher," twenty-five years prior to admission. The swelling in his left inguinal region appeared one year after the hernia was induced. The patient wore a truss for many years. Examination revealed a direct hernia which disappeared spontaneously in the recumbent position.

This patient was operated on by Dr. Paul Aschner. A small direct sac was found and ligated. Closure was effected by a typical Bassini operation.

CASE III.—H. R., thirty years of age, Russian, was admitted July 13, 1925, to the Surgical Service of Dr. A. A. Berg. He complained of a hernia of two years' duration. Examination revealed a hernial bulge in the left inguinal region just mesial to the pubic spine. The bulge disappeared spontaneously in the recumbent posture; evidently a direct hernia was present.

This patient was operated upon by Dr. Leon Ginzburg. A relatively large direct hernial sac was found adherent to the pubic spine. The vas was firmly adherent to the sac. The excess of the sac was ablated and the neck closed with a running catgut suture. The transversalis fascia was cleared and sutured. The internal oblique and the aponeurosis were sutured to Poupart's ligament. The cord was transplanted beneath the skin.

Before operation no history of artificial production of the hernia was obtained. In view of the unusual findings at operation the patient was subsequently questioned, and the following information obtained: About eleven years prior to admission, under anæsthesia, some manipulations were carried out with the idea of producing a hernia. In about two months, after taking snuff and performing strenuous work and exercise, a hernial bulge appeared. It has not increased materially since that time.

CASE IV.—G. N., thirty-eight years of age, Russian, was admitted April 11, 1928, to the private care of Dr. Leon Ginzburg, complaining of a hernia on the left side. There was a definite bulge on standing which disappeared in the recumbent posture. At operation the external inguinal ring was found covered by a moderately dense layer of scar tissue and was adherent to the subcutaneous fascia. After the external oblique aponeurosis was incised, it was found impossible to deliver the cord because of marked adherence to a large direct hernial sac. It was finally freed from the sac by sharp dissection. Though the sac was large the ring was relatively small. The sac was opened, the redundant portion excised, and the neck closed with a purse-string suture. The transversalis fascia was cleared and sewed to the shelving edge of Poupart's ligament. The aponeurosis of the external oblique was imbricated behind the cord, leaving the latter in a subcutaneous position.

Following the operation this patient was questioned and he admitted that many years ago while still in Russia he had a rupture made in order to evade military service.

CASE V.—S. B., forty-four years of age, Russian, was admitted November 7, 1929, to the private care of Dr. A. V. Moschcowitz with the diagnosis of recurrent artificial left inguinal hernia. The hernia was produced by a "felscher" in 1907. In 1913, before immigrating to this country, he had the hernia repaired; but it recurred very soon after the operation. Examination revealed a rather large left direct inguinal hernia. The

bulge presented at the lower angle of the previous operative cicatrix. There was present a wide defect in the transversalis fascia, admitting four fingers, the edges of which could be distinctly felt. This defect was just above the spine of the pubis and just lateral to the edge of the rectus muscle. A secondary operation was performed by Doctor Moschowitz.

CASE VI.—A. E., forty-two years of age, born in Russia, was admitted February 18, 1930, to the Surgical Service of Dr. A. A. Berg for treatment of peptic ulcer. Routine physical examination revealed also bilateral direct inguinal herniæ. The external ring admitted two fingers easily, and presented a triangular shape with the apex upward and outward. The mesial crus could not be lifted away from the underlying edge of the rectus muscle. Both crura were definitely thickened and rough, but were intact. There was a distinct hole in the transversalis fascia, the edges of which were quite thick. The diameter of this hole was about 4 centimetres in the transverse direction and about 2 centimetres in the supero-inferior direction. In the erect position there appeared a hemispherical bulge above the pubic spine just laterally to the edge of the rectus muscle. In the recumbent position the bulge disappeared spontaneously.

On questioning, the patient stated that twenty-two years ago he had a "felscher" produce a rupture for him. He was taken to an open field away from habitation and placed on his back with his hands clasped behind his head. The "felscher" knelt astride his thighs. He then invaginated the left side of the scrotum with his right forefinger, "Just like you are doing now," stated the patient as I was exploring his external ring. The "felscher" then tore something, and caused a great deal of pain. He was told to jump from tables and chairs and to do heavy lifting. In six weeks he returned to the "felscher" since a hernia had not yet appeared. The "felscher" told him that things had grown together again on the left side, and that he would have to repeat the procedure on the right side and the patient submitted to operation on the right side. Two months later no hernia appeared and he was accepted for military duty. Four months after going into the service, protrusions appeared on both sides and he was relieved from further duty because of his incapacity. These hernias have never given him any real trouble except that he is conscious of their presence. Partial gastroectomy was performed for his chronic peptic ulcer and he left the hospital well, without hernioplasty.

CASE VII.—R. L., sixty-eight years of age, born in Russia, was admitted April 3, 1930, for a cardiac condition, in the private care of Dr. Murray Mintz. Routine examination revealed, also bilateral direct inguinal herniæ. In about 1884, at the age of twenty-two, after sixteen months of service in the Czar's army, he employed a "felscher" to make him a hernia. This was done on the left side and was accompanied by excruciating pain. A rupture appeared on the very next day without any further effort. About one month later he presented himself to the camp surgeon complaining of his hernia. The surgeon accused him of malingering and threatened to imprison him. About eight months thereafter a new surgeon was stationed at the camp, and he relieved the patient from further military duty. This patient states that it was a common practice to have hernias made and that many of his comrades were relieved from further military duty by this means.

About fifteen years ago, in 1915, a hernia appeared on the right side, following the lifting of a heavy parcel. In the erect posture a hemispherical bulge develops on the left side just above the spine of the pubis. The external ring was triangular in shape and admitted one finger comfortably. The edges were thickened and the mesial crus fixed to the underlying edge of the rectus muscle; this crus did not present a distinct sharp edge of its own. In the transversalis fascia there was a hole, about 4 centimetres in diameter, the edges of which were distinct. On the right side the bulge in the inguinal region was more diffuse, more shallow than on the left side. The external ring was oval and barely admitted one finger. The mesial crus presented a sharp, thin edge which could be lifted from the underlying edge of the rectus muscle. The transversalis fascia was lax, and it did not contain a demonstrable defect or tear. In the recumbent posture the bulge on both sides disappeared spontaneously. In this posture very slight coughing caused a pro-

trusion of the hernia on the left side, whereas hard coughing was required to make the hernia apparent on the right side. These hernias have never caused the patient sufficient discomfort to require operative treatment.

Of the seven cases noted above, six were on the left side and two were bilateral. They were all direct and none were scrotal. In 1925, Joil,²¹ in his "Inaugural Dissertation," collected a series of 342 cases of artificial inguinal hernia. These were from various sources and appeared since the World War. It constitutes the largest series ever reported. The work is not available in the libraries of this country; however, a résumé is given by Wohlgemuth and Joil²² in a subsequent article which appeared in 1928. They report on twenty-four patients upon whom they operated personally.

The twenty-four cases reported on by Wohlgemuth and Joil reveal some interesting features. They were all produced in what was formerly South Russia; namely, Kief, Charkow, Bessarabia, and Podalia. The contents of the sac consisted, usually, of small intestine or omentum. The bladder presented in two cases. Incarceration was noted in one case; this complication is rare and in the series of 342 cases collected by Joil it occurred in only two instances. The incarceration in all instances occurred not at the neck of the sac but at some distance from it and was caused by fibrous bands formed secondarily.

DISCUSSION.—The theory of R. H. Russell²³ that all indirect hernias are congenital in origin and are due to the existence of a so-called preformed sac—*patent processus vaginalis*—is universally accepted. Regarding the etiology of direct inguinal hernia anatomical weakness of the muscular and fascial layers is taught to be the underlying factor. The transversalis fascia in these is of prime importance; a weakness or a defect in this structure plays a paramount rôle in the development of a direct hernia. Various factors such as weakness of the other layers, strenuous effort, obesity, increased intra-abdominal pressure, muscular atrophy, and a wide inguinal triangle are secondary although obviously important in the etiology. The significance of the transversalis fascia, though stressed by some authors, is for the most part not appreciated. A study of the etiology and anatomical defects of artificial inguinal hernia strikingly brings out the important rôle it plays. The necessity of suturing the tear in this structure when dealing with an artificial inguinal hernia is always so apparent that the operator never fails to execute this step. Although less obvious, because it is thinned out and spread over the hernial bulge, it is of equal importance to suture or reef this fascia in the operative treatment of the usual direct hernia. Recurrent direct inguinal hernia can be explained best by the failure to recognize and deal with the transversalis fascia. Following a hernioplasty for indirect inguinal hernia a recurrence in the form of a direct hernia is due either to a failure to recognize a concomitant direct hernia or to an inadvertent injury to the transversalis fascia during the operation. Likewise, direct hernia occurring after an Alexander operation is probably also due to injury to the transversalis fascia.

Another point clearly brought out is the rationale of a fascial repair as opposed to a combined fascial and muscular repair in dealing with direct inguinal hernia. Granting the importance of the transversalis fascia and the necessity of dealing with it, it is also essential to buttress this fascia. This cannot be done efficiently, if at all, by suturing the transversus and internal oblique muscles to Poupart's ligament as is done in the classical Bassini operation. Fascia can best be reinforced by other fascia. Thus, utilizing the aponeurosis of the external oblique without the use of muscle appears to be the rational procedure. Seelig and Chouke,²⁴ in a series of carefully conducted experiments, have shown that utilizing the muscle is not only useless but may actually be harmful. Moschcowitz²⁵ has obtained excellent results over a long period of years by a purely fascial and aponeurotic repair. He takes care to even excise the cremaster muscle where it would prevent a direct apposition of aponeurosis to fascia. He avoids inclusion of the muscle fibres of the internal oblique and transversus when placing his cardinal sutures in order to bring the mesial flap of the aponeurosis of the external oblique down to the shelving edge of Poupart's ligament. This flap is thus brought into direct contact with the repaired aspect of the transversalis fascia previously dealt with.²⁶

BIBLIOGRAPHY

- ¹ Gerster, A. G.: Inguinal Hernia Artificially Produced. *ANNALS OF SURGERY*, vol. lv, p. 602, 1912.
- ² Moschcowitz, A. V.: Transaction of the N. Y. Surgical Society. *ANNALS OF SURGERY*, vol. xxiv, p. 265, April 26, 1911.
- ³ Coley, W. B.: Inguinal Hernia, Artificial and Traumatic. *ANNALS OF SURGERY*, vol. lv, p. 602, 1912.
- ⁴ Syms, Parker: Transaction of the N. Y. Surgical Society. *ANNALS OF SURGERY*, vol. lv, p. 602, 1912.
- ⁵ Hesse, E.: Die chirurgische und gerechtlich-medizinische Bedeutung der künstlich hervorgerufenen Erkrankungen. *Arch. f. klin. Chir.*, vol. cxxxvi, pp. 275-291, 1925.
- ⁶ Moschcowitz, A. V.: *Hernia: Johnson's Operative Therapeutics*. Vol. iv, p. 42, New York, D. Appleton & Co., 1915.
- ⁷ Da Costa, J. C.: *Modern Surgery*. Ed. 9, p. 1120, Philadelphia, W. B. Saunders Co., 1926.
- ⁸ Sanizky: Beobachtungen über Soldaten und die zur Wehrpflicht einberufenen Personenum und Recruten, welche zur prüfung im Hospital gehalten wurden. *Med. Auszugesammlung des Warschauer Kriegshospitals*. Bull. ii, 1888. (In Russian; not read in the original. Quoted and reference cited by Galin, M. A., *vide infra*.)
- ⁹ Monkewitz: Zur Frage der kunstlichen Leistenbruche. *Aus dem Protokoll der Med. Versammlung im Warschauer Kriegshospital*. *Wratsch*, vol. xxii, p. 640, 1894. (In Russian; not read in the original. Quoted and reference cited by Galin, M. A., *vide infra*.)
- ¹⁰ Orlow, K. W.: Grundlagen der Diagnostik künstlicher und simulirter Krankheit bei Rekruten und Soldaten. *St. Petersburg, Dissert.* 1894. (In Russian; not read in the original. Quoted and reference cited by Krymow, A. P., *vide infra*.)
- ¹¹ Wroblewsky: Zur Frage der kunstlichen Hernien. *Med. Sammlung des Warsh. Ujasdow Hospitals*. (In Russian; not read in the original. Quoted and reference cited by Krymow, A. P., *vide infra*.)

ARTIFICIAL INGUINAL HERNIA

- ¹² Bornhaupt: Ueber die künstliche Erzeugung von Hernien behufs Befreiung von der Wehrpflicht. Verhand. s.X. intern. med. Congresses, vol. xiii, pp. 182-184, 1891.
- ¹³ Schulz: Die Diagnose der künstlichen Leistenbrüche. Wratsch, No. 50, 1893. (In Russian; not read in the original. Quoted and reference cited by Krymow, A. P., *vide infra*.)
- ¹⁴ Ignatow: Material zur Frage über künstliche Leistenbrüche. Nulit. Journal f. Med., B. 5, 1894. (In Russian; not read in the original. Quoted and reference cited by Galin, M. A., *vide infra*.)
- ¹⁵ Crasnoff, W.: Über künstliche Leistenbrüche. Nulit. Journal f. Med., Sept., 1895. (In Russian; not read in the original. Quoted and reference cited by Galin, M. A., *vide infra*.)
- ¹⁶ Galin, M. A.: Über Brüche der Leistengegend künstlich-traumatischen Ursprungs. Arch. f. klin. Chir., vol. lx, pp. 104-175, 1899-1900.
- ¹⁷ Krymow, A. P.: Die künstlichen und traumatischen Leistenbrüche. Arch. f. klin. Chir., vol. xci, pp. 754-795.
- ¹⁸ Solomka, N.: Die Leistenbrüche bei den Juden in unserer Armee. Jahrb. d. russ. Chirurgie, 1898. (In Russian; not read in the original. Quoted and reference cited by Krymow, A. P., *loc. cit.*)
- ¹⁹ Ginzburg, L.: Personal communication.
- ²⁰ Moschcowitz, A. V.: Personal observation.
- ²¹ Joil, A.: Inaugural Dissertation. Jassy, 1926. (In Rumanian; not read in the original. Quoted and reference cited by Wohlgemuth and Joil, *vide infra*.)
- ²² Wohlgemuth, and Joil: Artifizielle Leistenbrüche. Arch. f. klin. Chir., vol. cli, pp. 406-410, 1928.
- ²³ Russell, R. H.: Lancet, vol. ii, pp. 1128-1131, 1900.
- ²⁴ Seelig, and Chouke: A Fundamental Factor in the Recurrence of Inguinal Hernia. Arch. Surg., vol. vii, p. 553, 1923.
- ²⁵ Moschcowitz, A. V.: Personal communication.
- ²⁶ Reichle, R.: Über Gewaltbrüche. IX, Kunstliche Hernien. Ergebnisse d. Chirurgie u. Orthopaedie, vol. xx, pp. 354-357, 1927.

HERNIA INTO THE PREVESICAL SPACE

BY IRVING J. WALKER, M.D.

OF BOSTON, MASS.

FROM THE HARVARD SURGICAL TEACHING SERVICE, BOSTON CITY HOSPITAL

Two cases of hernia into the prevesical space are reported in this paper as an addition to the small number now recorded in the literature.

Since other types of hernia have their origin in the same region, namely, the supramesical fossa, it would seem fitting that the subject of hernia of this space should be given some consideration.

The supramesical fossa is a triangular area bounded laterally and above by the lateral umbilical folds which cover the obliterated hypogastric arteries, and below by the peritoneal reflection which passes from the anterior abdominal wall to the fundus of the bladder. On both outer sides of this area are the middle inguinal fossæ.

Herniæ originating in the supramesical fossa have been known for a long time (Cooper, 1804). They have been mentioned in the literature under various titles, such as that of Wilms,¹ prevesical; Waldeyer,² supramesical; Klebs,³ anterior retroperitoneal; Krönlein,⁴ properitoneal; Leser and Linhart,⁵ inner inguinal herniæ.

It is evident from these differences in terminology that the nomenclature has been based on various anatomical considerations. When a hernia has originated within the boundaries of the supramesical fossa, it would seem reasonable to accept the term advocated by Waldeyer and classify it as a supramesical hernia. Further elaboration of this classification can be made, dependent upon the structures or regions invaded by the hernia sac. As an example, the type of hernia discussed in this paper might well be called a supramesical hernia of the prevesical type.

The upper limit of the supramesical space in the region of the umbilicus is the tip of the angle formed by the junction of the lateral umbilical folds. In a downward direction the space widens between these ligaments as one approaches its lower aspect. The reflection of the peritoneum from the anterior abdominal wall backward to the fundus of the bladder marks the lower level of the fossa. Anteriorly, the space is limited by the musculature of the abdominal wall. Posteriorly, it is covered by peritoneum. Extending from the summit of the bladder to the junction of the lateral umbilical folds is the middle umbilical plica covering the urachus. This divides the supramesical fossa into a right and left half, sometimes termed the internal inguinal fossæ. The latter vary in depth according to the prominence of the folds above mentioned. Luttelmann^a states that these folds may protrude in the fashion of a comb, each having a more or less definite mesentery. Below the peritoneum forming the lower boundary of the supramesical fossa, and lying between the bladder and the pubic bone, is a more or less triangular area known as the prevesical space or Space of Retzius. Laterally this extends to the outer limits of the bladder. In depth it reaches to the prostate and its covering. The region is filled with varying amounts of areolar tissue and fat and is subject to change in size and shape according to whether the

HERNIA INTO THE PREVESICAL SPACE

bladder is filled or empty. It is with herniæ into the prevesical space that we are concerned in this paper.

Etiology.—Undoubtedly several factors enter into the etiology of those herniæ arising in the suprapvesical fossa. Increased prominence of the lateral and middle umbilical folds is unquestionably a factor in the production of

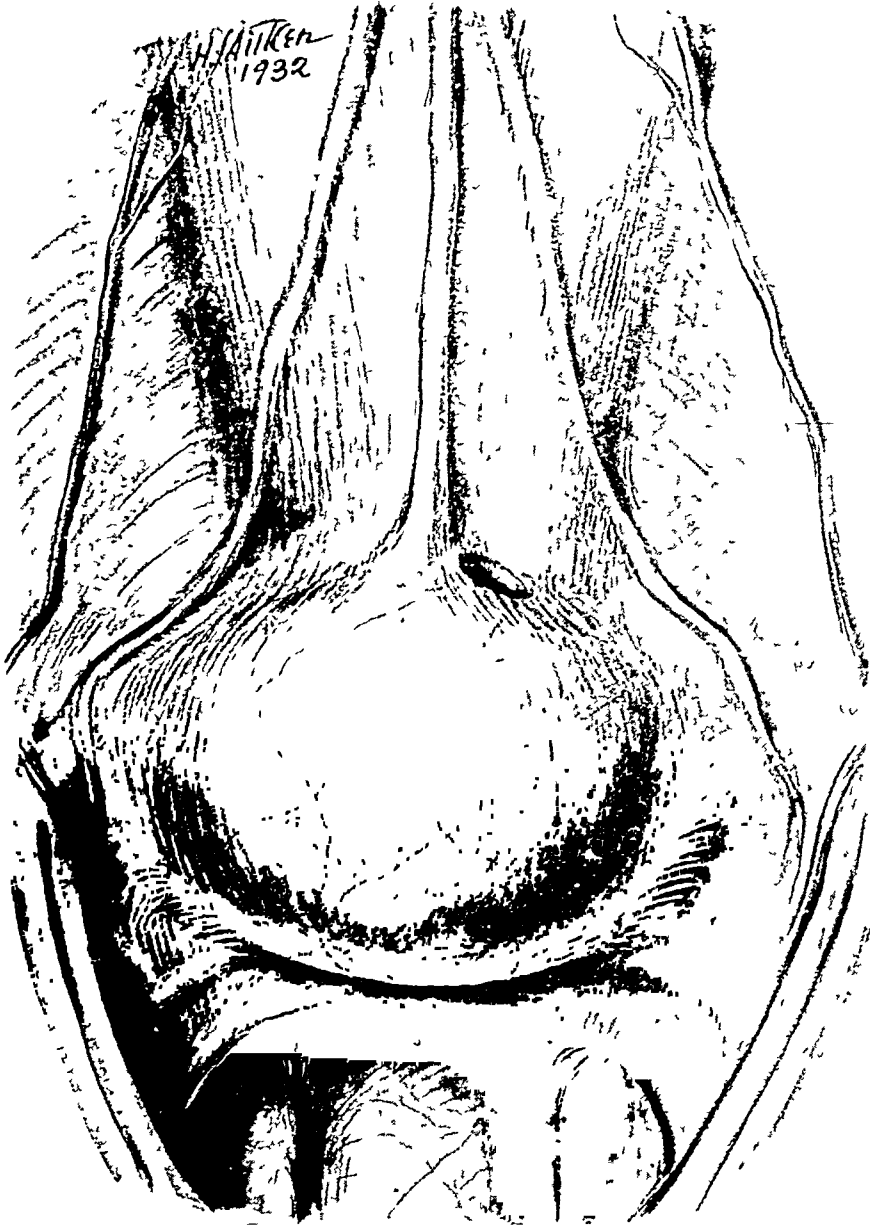


PLATE I

peritoneal pockets. Rokitansky,⁷ according to Reich,⁸ was the first to call attention to the occurrence of these suprapvesical peritoneal pockets and to the possibility of hernial incarceration in the same.

Also of importance in the production of these herniæ is the possibility of weakened areas in the adjacent anatomical structures. Incidentally, Luttelmann has pointed out that individuals presenting suprapvesical herniæ of the external form show a predisposition toward other types of hernia.

If for any reason the subperitoneal fat shows atrophy, there is an additional tendency for the peritoneum of the suprapvesical fossa to become invaginated.

Luttelmann adds another possibility by presenting the theory that a previously existing inflammation beneath the peritoneum of this area with resulting scar-tissue contraction might result in invagination of the peritoneum.

Increased intra-abdominal pressure has been mentioned as another factor in the production of those herniæ which appear upon the surface.

These herniæ undoubtedly start as small peritoneal pockets aptly described by Luttelmann as "swallow-nest" formation. They may remain as such, or may develop by penetrating the abdominal wall, later demonstrating themselves as external forms of hernia. Because of the anatomical structure certain ones cannot ever appear upon the surface.

Where the musculature of the abdominal wall has been invaded, but where the sac does not appear upon the surface, this form of hernia has been termed interstitial.

After carefully reviewing case reports, we find that herniæ arising in the suprapvesical fossa tend to develop in three directions, dependent upon the part of the fossa in which the peritoneal opening is found. From this observation, which we do not offer as a constant rule, we can divide the suprapvesical fossa into three more or less distinct regions.

The first portion is represented by the area on the peritoneum overlying which is the rectus muscle. A hernia arising within this area points forward and should there be weakness of the rectus muscle may present itself upon the surface. In formation this may be likened to the well-known epigastric hernia; from its location, it can be termed hypogastric.

The second portion is a triangular area bounded on the inner side by an imaginary line on the peritoneum, representing the outer border of the rectus muscle; on the outer side by the lower part of the lateral umbilical plica, and below by the reflection of peritoneum extending from the anterior abdominal wall to the bladder. The width of this portion varies with the width of the rectus muscle together with the distance between the lateral umbilical folds. A hernia arising in this area has a tendency to point laterally outwards. Should there be weakness of the abdominal wall, it may appear upon the surface at the outer border of the rectus muscle, over or through the inguinal falx, above the lacuna ligament or just to the inner side of the femoral opening. In most cases, such herniæ, as Roser⁹ and others have pointed out, carry ahead of the sac a lipomatous formation which unquestionably is a factor in their tendency to develop toward the surface. Many of these have been operated upon with the diagnosis of femoral hernia.

The third portion is represented by the peritoneal reflection which covers the Space of Retzius. Hernial formation originating in this area has a tendency to push downwards into the prevesical space. Because of the rigid anatomical structure, the pubic arch, on the anterior aspect of this space, such a hernia never becomes external.

HERNIA INTO THE PREVESICAL SPACE

The literature reveals numerous herniæ arising in the first two portions. As a matter of fact, those arising in the second portion constitute the greatest number of so-called herniæ of the supravescical fossa.

Reich's collection of cases and description of supravescical hernia is the first one in the literature covering the subject. The topic has also been discussed by Vogeler,¹⁰ Marconi,¹¹ Luttmann, Waldeyer, Watschugoff,¹² Bayer,¹³ Schiele,¹⁴ Kudrnac,¹⁵ Brentano,¹⁶ Belu,¹⁷ Jæhne,¹⁸ Fromme,¹⁹ and others.

Hernia into the prevesical space, judging from the number of cases reported, is a rare condition. Personal interviews and communications with certain anatomists reveal none found in the cadaver. Cases I and III of Reich, and an additional one cited by Maydl,²⁰ are apparently the only ones reported to date, which leave little doubt as to their being herniæ into the prevesical space. There are other cases which because of inadequacy of reports and descriptions cannot definitely be considered by us to be prevesical herniæ, although certain of them may be such. Case II of Reich, as well as the single case of Brentano, and Case II in the series of Watschugoff, fall into this group.

To the three mentioned above we are adding two more, making a total of five cases of hernia into the prevesical space which have been reported to date according to our findings and case interpretations.

• CASES REPORTED

CASE I.—J. D., male, aged fifty-one years, entered the hospital November 10, 1929, with the chief complaint of abdominal pain and vomiting. He stated that four days before a left inguinal hernia which had been present for years became pinched in the truss he was wearing. He noted pain in the region of the left external inguinal ring. The pain was cramp-like and lasted for twenty-four hours. After an interval of eighteen hours without pain, the latter recurred. There was no vomiting until six hours after the second onset of pain. The vomitus, at first light green in color, was later dark and of foul odor. An enema produced gas but did not relieve the pain. He had some frequency of urination for four days preceding entrance to the hospital.

Abdominal examination showed general distension with tenderness but no spasm. Auscultation revealed marked increase in peristalsis. Both hernial rings showed impulses on cough, but no evidence of a strangulated hernia. By rectal examination there was a moderately enlarged prostate. Pulse, 110. Respiration, 20. Temperature, 99.5°. Blood-pressure, 118/80. White count, 12,000.

The diagnosis of acute intestinal obstruction of unknown etiology was made.

Operation under spinal anæsthesia revealed an opening in the peritoneum three-fourths of an inch in diameter to the right of the umbilical ligament just anterior to the fundus of the bladder as illustrated in Plate I. Within this sac was a loop of strangulated ileum. The peritoneal edge of the sac was incised. A loop of viable bowel was removed from the sac. The latter extended two inches downwards into the prevesical space. The peritoneal lining of the sac could not be evaginated. The edge of the ring of the sac was freshened and the opening closed with a continuous catgut suture. The convalescence was uneventful. His health has remained good since leaving the hospital. There has been no frequency of urination such as existed just prior to operation.

CASE II.—F. R., male, aged sixty-three years, was first seen in the hospital February 3, 1930. He stated that two days previously, shortly after eating fish, he was seized with abdominal cramps and vomiting. He had vomited off and on since then. The vomitus was at first light yellow in character but later was brown. His bowels had not moved since the onset of pain, even with cathartics. There were no other symptoms, other than some frequency of urination, which had been present for several years.

Physical examination was essentially negative except for the abdomen. This showed considerable distension with tenderness, but no spasm, or visible peristalsis. There was increased auscultory peristalsis. On the right was an enlarged external inguinal ring, through which a definite impulse could be felt on cough. There was no evidence of a strangulated hernia. Rectal examination was negative. Temperature, 99°. Pulse, 120. Respiration, 25. Blood-pressure, 134/80.

A pre-operative diagnosis of intestinal obstruction of unknown origin was made, and operation advised. Exploration under spinal anaesthesia revealed no abnormality except a loop of ileum strangulated within a peritoneal pocket near the apex of the bladder, just to the right of the umbilical ligament. This was released after a small incision was made in the peritoneal edge of the ring. The bowel was found to be dark in color but viable. The opening of the sac was about one inch in diameter. The sac itself was about two inches long, extending downwards anteriorly to the bladder into the prevesical space as shown in Plate II.

The edges of the ring were freshened and the opening closed with a continuous suture of catgut. Because of the marked toxæmia accompanying

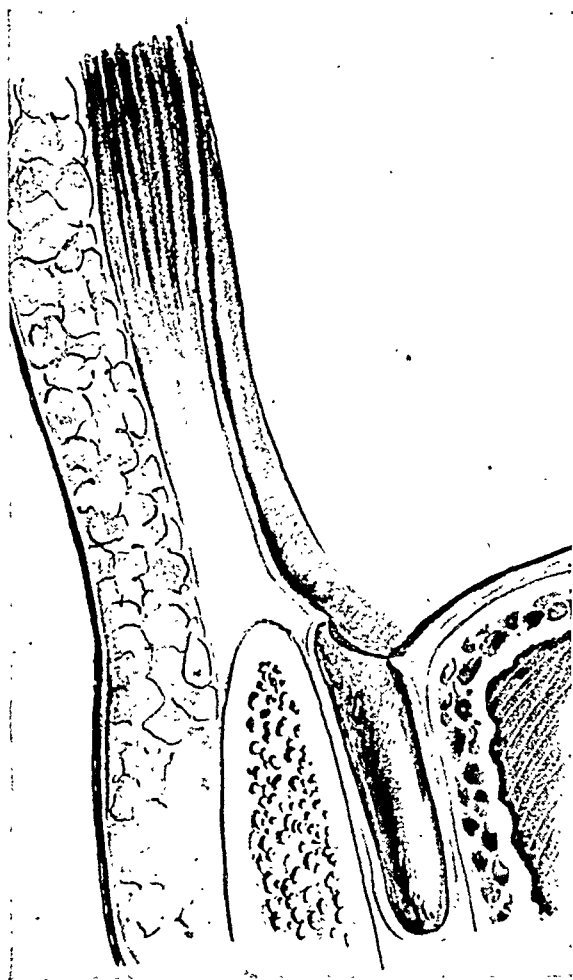


PLATE II

the obstruction, a jejunostomy was done. The convalescence was uneventful. On February 28, 1930, he was cystoscoped with negative bladder findings. A cystogram was also negative.

Symptomatology.—Since herniæ into the prevesical space never demonstrate themselves upon the surface it is obvious that they will be discovered only incidentally in abdominal exploration or when they are attended with symptoms of intestinal obstruction which have led to operation. It is a fact that the pre-operative diagnosis of hernia into the prevesical space has never been made. The condition is apparently one affecting males of adult years. One can assume, we believe, that these herniæ give rise to no symp-

toms unless a viscus is present within the sac. With incarceration or strangulation of a viscus in a prevesical hernia, because of the proximity of the same to the bladder, one might expect some evidence of micturitional disturbance. Reich mentions that frequency of urination should be a common finding. However, since these cases occur in males of advanced years in whom prostatic disease is possible, urinary frequency is likely to be attributed to hypertrophy of this gland. A careful history taken post-operatively in our cases showed that frequency was present in Case I. In this instance it was of short duration, was relieved by operation, and has not recurred. In our second case the frequency could be explained by hypertrophy of the prostate. We feel that frequency of urination in cases of strangulation of a viscus in a hernia into the prevesical space can be considered a positive symptom of this condition, other causes of frequency having been eliminated. We also think that cystoscopical examination in the presence of a strangulated hernia into the Space of Retzius would reveal a bulging on the anterior wall of the bladder, produced by the tumor mass. Practically, such a positive finding might be of value in establishing the exact nature of the condition causing the obstruction. On the other hand, cystoscopical examination could be criticized as possibly adding to the risk.

The symptomatology that has led to operation in all cases reported has been that associated with acute intestinal obstruction. In any case, it is possible that there may have been previous attacks of ileus which have disappeared spontaneously. Such finding in the history should be of some significance in establishing the diagnosis.

The small bowel has been the strangulated viscus mentioned in all cases reported. Since the symptom complex of intestinal obstruction is so well known, it would seem unnecessary to further elaborate on that subject in this paper.

Reich has emphasized the importance of the presence of tenderness over the bladder and the presence of distended loops of intestine in the region of the symphysis as significant findings in the physical examination. Such observations were not noted by us.

Treatment.—Regardless of the value of the positive diagnosis of a strangulated hernia into the prevesical space, the treatment becomes that of combating toxæmia, followed by laparotomy. At operation the viscus will be found to be constricted by the opening of the hernial sac. In our cases it was not possible to release the intestine without first having made a small incision in the dense edge of the peritoneum forming the ring of the sac. This having been accomplished, the intestine was readily replaced within the abdomen. In neither instance could we evaginate the sac with the idea of excising it without considerable dissection, which we considered unwise in the presence of intestinal obstruction. The procedure which we followed and which we advise in all such cases of strangulated but viable intestine was release of the strangulated bowel, a freshening of the edges of the peritoneum making up the ring, and a closure of the latter by a continuous

suture. Obviously, with a non-viable viscus the operative procedure will become more elaborate.

The post-operative care should be directed towards treatment of the toxæmia of the patient. Upon the degree of the latter hinges to a great extent the outcome of any individual case.

SUMMARY

Hernia into the prevesical space is a rare type of internal hernia originating in the supramesocolic fossa.

An accurate pre-operative diagnosis of hernia into the prevesical space is possible but hardly to be expected.

The operative treatment offers no unusual problem.

The prognosis depends upon the degree of toxæmia accompanying the condition of strangulation when this is present, the ability or not to have recognized a hernia within the prevesical space, and the operative procedures involved in the individual case.

BIBLIOGRAPHY

- ¹ Wilms: Der Ileus. Deutsche Chirurgie. Lieferung, 46 g., 1906.
- ² Joessel-Waldeyer: Handbuch der topographisch-Chirurgischen Anatomie mit Einschluss der Operations—übungen an der Leiche. Nach dem Tode des Verfassers fortgesetzt von W. Waldeyer, 1884-1889.
- ³ Klebs, Edwin: Handbuch der pathologische Anatomie. Bed. i, 1869.
- ⁴ Krönlein, R. U.: Hernia inguino-properitonealis incarcerata. Arch. f. klin. Chir., vol. xix, pp. 408-420, 1875-1876.
- ⁵ Linhart, W.: Vorlesungen über Unterleibs-Hernien. Würzburg, 1866.
- ⁶ Luttelmann, J.: Ueber supramesocolic Hernien. Breslau, 1919.
- ⁷ Rokitsky, Carl: Lehrbuch der pathologischen Anatomie. 3 Aufl., vol. iii, 1861.
- ⁸ Reich, A.: Ueber eine neue pericoecale Hernie, die Hernie des Recessus coecalis. Beitr. z. klin. Chir., vol. lxiv, pp. 1-34, 1909.
- ⁹ Roser, quoted by Luttelmann and Vogeler.
- ¹⁰ Vogeler, Karl: Die supramesocolic Hernien. Beitr. z. klin. Chir., vol. cxviii, pp. 318-341, 1919.
- ¹¹ Marconi, Albert: Hernia supramesocolic-externa. Wien. Med. Woch., vol. lxx, pp. 512-514, 1920.
- ¹² Watschugoff, A. P.: Ueber die intraabdominalen Hernien der Foveae supramesocolicæ auf Grund dreier eigener Beobachtungen. Deut. Zeit. f. Chir., vol. ccxxx, pp. 342-344, 1931.
- ¹³ Bayer, Carl: Hernia juxtamesocolic dextra incarcerata. Zentralbl. f. Chir., vol. xlix, pp. 671-673, 1922.
- ¹⁴ Schiele, George: Hernia supramesocolic interna incarcerata. Zentralbl. f. Chir., vol. liii, pp. 1252-1254, 1926.
- ¹⁵ Kudrnac: Hernia juxtamesocolic incarcerata dextra. Zentralbl. f. Chir., vol. liii, pp. 88-89, 1926.
- ¹⁶ Brentano (Freie Vereinigung der Chirurgen Berlins) Hernia retroperitonealis anterior sinistra. Zentralbl. f. Chir., vol. xxiv, p. 821, 1897.
- ¹⁷ Belu, N.: Hernia juxtamesocolic incarcerata dextra. Zentralbl. f. Chir., vol. liii, pp. 1124-1125, 1926.
- ¹⁸ Jähne, A.: Beitrag zur operativen Behandlung der inneren Hernien. Beitr. z. klin. Chir., vol. lvi, pp. 439, 447, 1907-1908.
- ¹⁹ Fromme, Albert: Über einen Fall von Hernia retroperitonealis anterior sinistra incarcerata. Deut. Zeit. f. Chir., vol. xcii, pp. 365-371, 1908.
- ²⁰ Maydl, K.: Die Lehre von den Unterleibsbrüchen, 1898.

INTERSIGMOID HERNIA

BY DENVER M. VICKERS, M.D., AND STANLEY T. FORTUINE, M.D.
OF CAMBRIDGE, N. Y.

FROM THE SURGICAL SERVICE OF THE MARY MCCLELLAN HOSPITAL

INTERSIGMOID hernia, of all the types of internal hernias, still remains one of the more unusual surgical conditions. Although anatomists agree that the intersigmoid fossa can be demonstrated in a considerable proportion of cases coming to their attention, surgeons, in the operating rooms or wards, meet with intersigmoid hernia very infrequently.

Internal hernia, in general, presupposes the protrusion of abdominal contents through some ring entirely within the abdomen. Of the various possibilities, those about the duodenum are probably most common; the so-called paraduodenal hernia, with the protrusion of bowel through some fossa left on the developmental attachment of the duodenum to the posterior abdominal wall. Nine sub-varieties of this hernia have been described,¹ with the sac at various points behind the duodenum.

Another group are found about the cæcum or ascending colon; the ileo-colic or ileo-cæcal hernias, of which four varieties have been described.² In these, the sac is between the layers of the ascending mesocolon, with the difficulty arising from the embryological rotation and attachment of the colon and cæcum to the posterior parietal peritoneum.

Others occur through the transverse mesocolon, through rents in the broad ligament, and into the always-present foramen of Winslow. And a smaller group have been reported in the region of the sigmoid colon. It is this condition, of intersigmoid hernia, that we are now discussing.

All of this group of hernias are protrusions through an opening which is performed, and not the result of some operative or inflammatory condition, though these conditions doubtlessly are more often the cause of acute obstruction of the intestine.

The intersigmoid fossa is described in Gray's Anatomy³ as a distinct and fairly constant structure. It is usually present in the foetus, and frequently found during infancy, but gradually disappears in a majority of cases as age advances. It is best seen by drawing the sigmoid colon upward and to the right, thus exposing its attachment to the posterior abdominal wall. Here lying on the external iliac artery, in the space between the psoas and iliacus muscles, there is a pouch, funnel-shaped, with the opening to the left and downward. This varies in size from a mere dimple to a definite sac. It has been described as being like the middle finger of a surgeon's rubber glove. It is behind the sigmoid mesocolon, and in front of the parietal peritoneum.

The older authorities found this anatomical landmark in varying proportions. Treves⁴ is quoted as finding the fossa in 52 per cent. of all cases;

Waldeyer⁵ in 84 per cent.; Moynihan⁶ in 70 per cent.; and of recent workers, Bruce and Ross⁷ in 1924 examined forty-six cases and found the fossa present in 80 per cent. But in distinct contrast to the frequency with which this fossa is found by anatomical research is the infrequency with which it is seen by the surgeon. The fossa must be frequently present, but apparently the bowel is very infrequently caught in it, as clinical cases are very rare. There is no differential pressure to aid in the production of an internal hernia, as there is in hernia through the ordinary sites, although peristalsis can act very much in the same fashion and accomplish the same result. Apparently, the opening is usually covered by the surrounding layers in a fairly efficient fashion.

Bruce and Ross,⁷ in 1924, found nine cases in the literature up to that time, and added a tenth. These cases included the early fatal cases of Eccles⁸ and Eve,⁹ which were observed around 1885, much prior to the other cases in the series. Then a fatal case of Lambret,¹⁰ found at operation, and a case in a newborn infant, also fatal, reported by Coley.¹¹ Up to 1908, these four, the first two of which have been questioned, were the only cases on record.

The first successful case was that of Krall,¹² in 1910, a man who was operated on and recovered. Machol¹³ reported a case in a man of sixty-six, and next we find the autopsy findings of a well-described case by Nuzum and Nuzum;¹⁴ then the recovered case of Taylor,¹⁵ a case cited by J. B. Murphy,¹⁶ in his Clinics, and the very large hernia into the intersigmoid fossa, reported by Bruce and Ross,⁷ in 1924, from Toronto. This case was operated on, but the bowel was gangrenous over such an extent that resection could not be done, and the exact condition was described, very accurately and completely, from the autopsy a few hours later. Of these ten, only three were reported as having lived; in other words, there was a very high mortality connected with the diagnosis of intersigmoid hernia.

Since this report and summary of ten cases, a few more have appeared in the literature. H. Erkes¹⁷ in 1923, from Leipzig, reported the case of a man of twenty-one, with a history of twenty-four hours' obstruction. This patient was operated on, had a loop of bowel removed from the intersigmoid fossa and made a good recovery.

In 1926, A. J. C. Hamilton¹⁸ had a case in Edinburgh. A woman of forty-three, with a history of obstruction for two days, was operated on, and a loop of bowel 12 inches long removed from the intersigmoid fossa. The patient made a good post-operative recovery, but died on the nineteenth day, apparently from the rupture of an intra-thoracic aneurism.

The same year, McCarthy¹⁹ had a case in Erie, Pa. A boy of twenty was operated on seventeen hours after the beginning of his obstruction. Operation showed extensive gangrenous small bowel, and he died in six hours.

The next year, Kostic²⁰ reported a similar case from Leipzig. A woman of thirty-three, with the usual symptoms of intestinal obstruction, was operated upon, a loop of bowel removed from the intersigmoid sac, and the patient made a good recovery.

This brings the series, including the case that is being reported here, to a total of fifteen cases. The mortality in the last group, excluding the case

of Hamilton, where death was due to thoracic disease, was one out of five. This is perhaps due to the more recent general recognition of the fact that in any type of intestinal obstruction early operation is imperative. Of course no formal conclusions can be drawn from a small series. So this brings the total mortality, excluding the case of Nuzum and Nuzum,¹⁴ where the condition was found at autopsy, with death due to another factor, to seven out of fifteen cases, or 47 per cent. These, with the exception of the infant reported by Coley, were all patients of adult life, generally from twenty to fifty-five years. Most of them were in men; a few were in women.

Treatment is essentially surgical. Diagnosis is practically never made before operation. These hernias can usually be reduced by gradual traction, and if the bowel is not viable, it should be resected. In the reported cases, no attempt has been made to close the sac, and this seems not only technically difficult but unnecessary.

REPORT OF AUTHORS' CASE.—M. F. W., Hospital No. 4988, a white boy of eighteen years, was admitted to the Mary McClellan Hospital October 13, 1929, complaining of vomiting. His father and mother were living and well; he had two sisters living and well, and none had had trouble similar to his own. His general health had been good until the present illness. About a month before admission, he noticed dull pain in the right side of the abdomen, which occasionally became colic-like, or more severe. This continued in moderate form, but he was able to continue his work regularly at school. Two days before admission, while playing ball, he was bruised on the left side and had rather severe immediate pain. During the next twenty-four hours, the pain became more intense and more severe near the umbilicus. He vomited several times, and retained practically nothing by mouth. His bowels had not moved for three days.

He was a well-developed and nourished boy of eighteen, considerably distended, with occasional "intestinal patterns" over the abdomen. He appeared prostrated and acutely ill. General physical examination was negative. His heart sounds were good and his lungs clear. His temperature was 100.5° and his pulse 100. There was no sign of inguinal, femoral or umbilical hernia. Rectal examination gave no further information. Intestinal obstruction was evident.

The abdomen was opened under spinal novocaine. A greatly dilated small intestine presented itself, which on being traced down led to a loop caught in a small opening about the size of the index finger, in the left side of the sigmoid mesocolon, and approximately over the left iliac artery. Through this foramen approximately half of the circumference of the loop of bowel was caught. In other words, this was a partial enterocele, or a Richter's hernia. This bowel was gently extracted. It appeared viable, and resection was not done. The abdomen was closed in layers, with a small drain going down to the fascia. The patient's bowels moved while he was on the operating table.

For the first twenty-four hours, his post-operative course was rather stormy. He was given fluids intravenously and subcutaneously. Gradually his condition improved and he was given fluids by mouth. He was on soft diet at the end of a week. His pulse and temperature gradually came down, and his wound healed. He was allowed out of bed in two weeks, made a good convalescence, and has had no further trouble.

BIBLIOGRAPHY

- ¹ Coley, B. L.: Strangulated Left Duodenal Hernia. Arch. Surg., vol. xviii, p. 868, March, 1929.
- ² Coley, W. B., and Hogue, J. P.: Retrocæcal Internal Hernia. ANNALS OF SURGERY, vol. xc, p. 765, October, 1929.

- ³ Gray's Anatomy, p. 1267. Lea and Febiger, Philadelphia, 1913.
- ⁴ Treves: Hunterian lectures.
- ⁵ Waldeyer: Quoted by Eve.
- ⁶ Moynihan, B. G. A.: Retroperitoneal Hernia. Wm. Wood and Co., New York.
- ⁷ Bruce, H. A., and Ross, J. W.: Intersigmoid Hernia. Surg. Gynec. and Obstet., vol. xxxix, p. 15, July, 1924.
- ⁸ Eccles, MacAdam: Quoted by Bruce and Ross.
- ⁹ Eve, F. S.: Quoted by Bruce and Ross.
- ¹⁰ Lambret: Quoted by Bruce and Ross.
- ¹¹ Coley, W. B.: Strangulated Retroperitoneal Hernia of the Intersigmoid Fossa. Tr. Am. Surg. Assn., vol. xxvii, p. 445, 1909.
- ¹² Krall: Quoted by Bruce and Ross.
- ¹³ Machol: Quoted by Bruce and Ross.
- ¹⁴ Nuzum, F., and Nuzum, J.: Quoted by Bruce and Ross.
- ¹⁵ Taylor, G.: Quoted by Bruce and Ross.
- ¹⁶ Murphy, J. B.: Quoted by Bruce and Ross.
- ¹⁷ Erkes, H.: Ztrb. f. Chir., vol. 1, p. 306, February 24, 1923.
- ¹⁸ Hamilton, A. J. C.: Edinburgh Med. Jour., vol. xxxiii, p. 448, July, 1926.
- ¹⁹ McCarthy, F. P.: Atlantic Med. Jour., vol. xxix, p. 872, September, 1926.
- ²⁰ Kostic, M.: Ztrb. f. Chir., vol. liv, p. 962, April 16, 1927.

STRANGULATED FEMORAL HERNIA*

ANATOMY AND SURGICAL TREATMENT

BY VIRGIL S. COUNSELLER, M.D.

DIVISION OF SURGERY, THE MAYO CLINIC

AND

FOREST W. COX, M.D.

FELLOW IN SURGERY, THE MAYO FOUNDATION

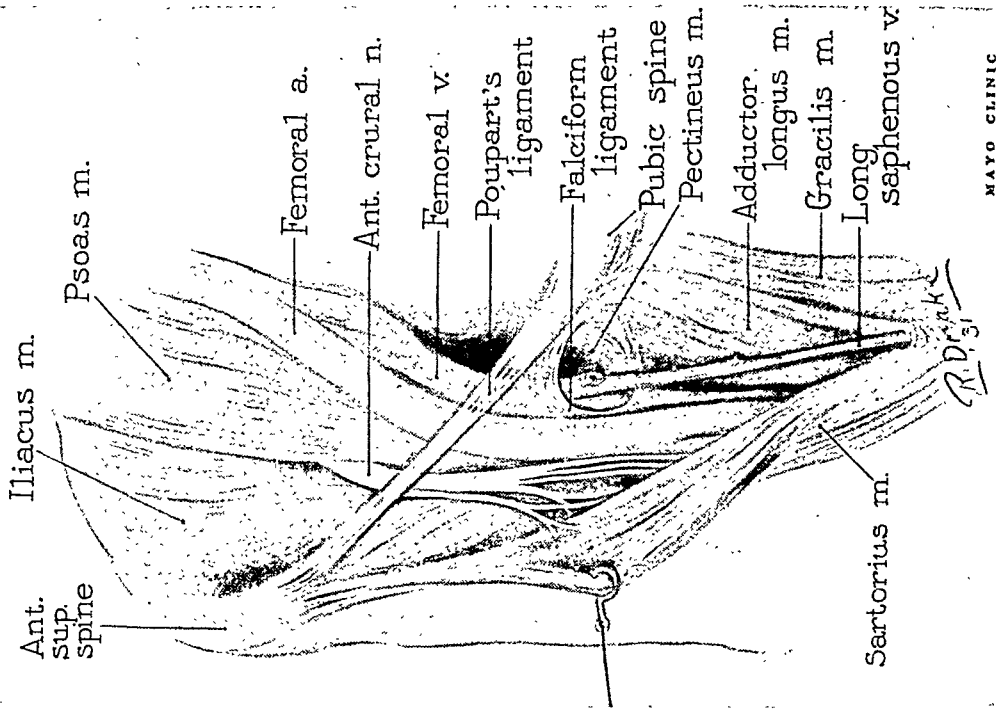
OF ROCHESTER, MINN.

THE incidence of femoral hernia has been variously reported by different authors. Coley¹ stated that the proportion of femoral to inguinal hernia at the Hospital for Ruptured and Crippled is as 1 to 17, and the same at the London Truss Society. It is relatively much more common among females than males, although even among females inguinal hernia is much the more common type. Femoral hernia is usually unilateral; the right side is more frequently involved than the left. It rarely attains the large dimensions that are not uncommon in inguinal, umbilical or post-operative hernia. Strangulation is believed to be more common than in inguinal hernia, because of the small and rigid orifice through which the protrusion occurs, and the unyielding, sharp-edged fascia that forms the anterior wall of the canal.

Successful repair of femoral hernia requires complete acquaintance with the anatomy of the femoral region, and since it is often poorly understood, we have had Figs. 1 and 2 prepared, which demonstrate accurately the true relationship of the important structures. It can be seen in Fig. 1 that the femoral vessels lie on a muscular floor composed of the iliacus, psoas and pectineus muscles and separated from them by a tough fascia which surrounds the muscles and becomes a part of the femoral sheath. The femoral vein is adjacent to the femoral canal, and as the hernial sac proceeds through the short canal and out through the fossa ovalis, it is in contact with the terminal portion of the long saphenous vein which enters the femoral vein through the fossa ovalis. (Fig. 2.)

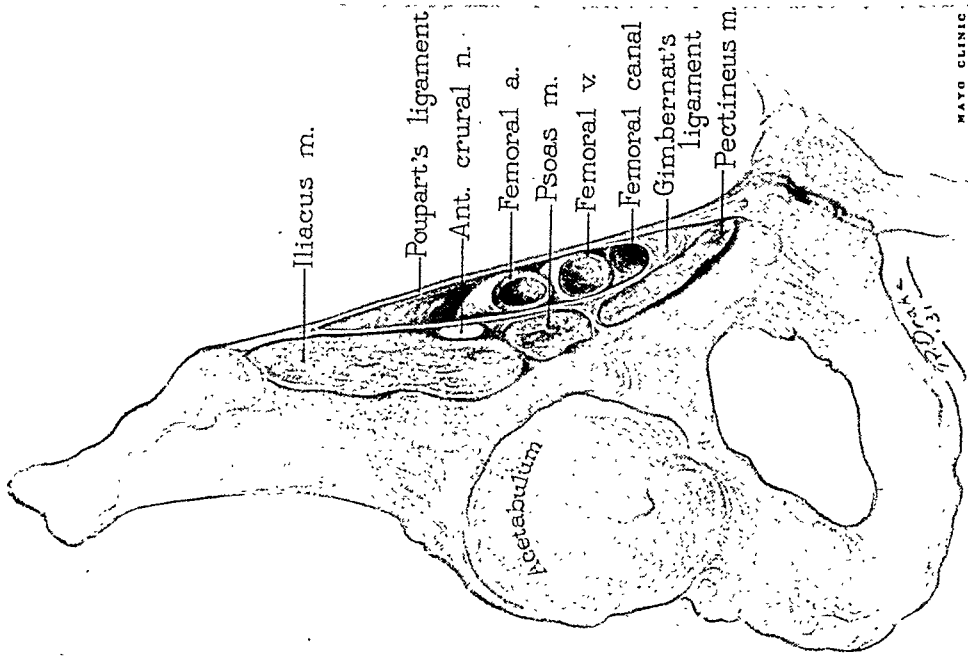
The femoral sheath is a conical, membranous investment of the femoral vessels. It is derived from the fascial lining of the abdominal cavity. The fascia transversalis is carried distally in front of the vessels, and the iliac fascia behind them, as they pass from the abdomen into the femoral triangle. The sheath is about 3.75 centimetres in length, and is divided into three compartments: namely, a lateral compartment for the artery, an intermediate compartment for the vein, and a mesial compartment, containing lymph-vessels and fat, named the femoral canal. (Fig. 1.) For clearness, the fascial bands separating the sheath into three compartments are not shown in the drawing. External to the femoral artery lies the anterior crural nerve. The femoral canal is the passage through which a femoral hernia enters the thigh. Its mouth, or proximal end, is the femoral ring, bounded anteriorly by the inguinal (Poupart's) ligament, posteriorly

* Submitted for publication December 15, 1931.



MAYO CLINIC

FIG. 2.—Anterior view of the femoral and inguinal regions. The sartorius muscle is retracted laterally, showing the relationship of the femoral vessels as they pass under Poupart's ligament. The muscles of the abdominal wall have been removed.



MAYO CLINIC

FIG. 1.—Cross-section of the femoral and inguinal regions in the plane of Poupart's ligament and passing through the acetabulum.

STRANGULATED FEMORAL HERNIA

by the origin of the pectineus muscle from the pubis, mesially by the lacunar (Gimbernat's) ligament, and laterally by the femoral vein. The femoral canal ends in the fossa ovalis. Its distal part is under cover of the fascia cribrosa, while the superior cornu of the falciform margin crosses over it and conceals its proximal portion. (Fig. 2.) The course of a femoral hernia is determined by that cornu. The hernia descends through the femoral ring, and after passing into the femoral canal is directed through the fossa ovalis. The anterior part of the hernia is pressed on and retarded by the femoral arches; the posterior part pushes onward, hooks around the cornu, over the falciform edge, and is directed upward over the inguinal ligament. The points of strangulation are at Gimbernat's ligament and the falciform edge of the saphenous opening. The coverings of a femoral hernia, in addition to peritoneum and extra peritoneal tissue, are femoral sheath, fascia cribrosa, superficial fascia, and skin.

Perhaps the most cogent reason for reporting these cases is that they give an opportunity to reëmphasize the high mortality attending strangulated femoral hernia. Gibson³ gives 47 per cent. as the mortality noted thirty years ago, and with all of our increased knowledge of physiological disturbances in intestinal strangulation in general, which have become known since then, the mortality has decreased but very little. However, it is only fair to state that there are certain factors which contribute to the mortality over which we have very little control. Patients with femoral hernia are likely to be old, and senility, beyond all question, is one of the principal causes, since, when patients are old, pneumonia frequently develops, and usually is rapidly fatal. The incidence of pulmonary embolism is increased among old people, which may be due to a drop in blood-pressure and retardation of the flow of blood. The cardiovascular systems of old patients cannot tolerate the prolonged general anæsthesia or the marked drop in blood-pressure from spinal anæsthesia which has been known to occur if patients had definite myocardial degeneration. Failure to recognize the condition and to refer the patient for early operation adds to the mortality. Fowler² stated that of all reported cases of Richter's hernia, wherever situated, 50 per cent. were unrecognized early, and that all the patients died. Femoral hernia frequently takes the form of Richter's hernia, which never includes the complete circumference of the bowel, and in the majority of cases the obstruction is only partial. Frequent and futile attempts at reduction by manipulation often cause delay, which could well be avoided. The magnitude of the accident and the seriousness of the symptoms may be discredited by patient and physician alike, mainly because the obstruction may not be complete. In Case I, obstruction was incomplete, although one-half of the circumference of the bowel was slowly being injured. In this instance the hernia occurred seventy-two hours before admission, and although symptoms of partial obstruction were present, the patient did not seek relief until fifty-six hours later.

The following two cases are of interest on account of the advanced age of the patients, because both types of strangulation usually seen in femoral hernia are represented, and because the patients recovered following operation.

CASE I.—A woman, aged eighty-six years, while straining at stool three days prior to registration at the clinic, had a sudden enlargement of an old femoral hernia of the

right side, which could not be reduced. At once, she began to have severe, cramp-like pains in the hernia, which were continuous. Nausea and repeated attacks of vomiting occurred intermittently, but the vomitus became fecal in character twenty-four hours prior to her admission. Neither gas nor feces had been passed since the onset of the attack.

There was a history of recent œdema of the legs, graded 3, but it had nearly disappeared before this accident. The patient had a moderate amount of dyspnoea and dizziness on exertion. The cardiac tones were clear, but rhythm was irregular, and there were extra systoles. The blood-pressure was 160 millimetres of mercury systolic and 100 diastolic. The abdominal wall was thin and flat. There was an irreducible, strangulated, right femoral hernia about four by seven centimetres. A tympanic note was elicited on percussing the mass. Leucocytes numbered 21,000 in each cubic millimetre of blood. Immediate surgical repair was advised.

Under local anæsthesia, the sac was easily exposed after sectioning the falciform edge of the fascia above the saphenous opening. It contained a piece of omentum and a knuckle of ileum (Richter's hernia). The omentum was pulled out and excised, which



FIG. 3.—Section of ileum removed in Case II. The devitalized portion is evident.

at once relieved the pressure on the ileum, and the normal color of the strangulated bowel returned. The bowel was replaced in the abdomen and the hernia repaired by suturing Gimbernat's ligament and the pectineus fascia to the lower edge of Poupart's ligament with interrupted sutures of No. 2 chromic catgut. Convalescence was not complicated, and the patient was dismissed from the hospital on the twelfth post-operative day.

CASE II.—A woman, aged seventy-seven years, for one year had had a painless swelling, about 2.5 centimetres in diameter, in the right femoral region. Thirty hours prior to registration at the clinic, this swelling had suddenly increased to approximately ten centimetres in diameter, and she had begun to have excruciating abdominal pain, associated with severe vomiting. All attempts to reduce the hernia had failed.

On examination there was a large, oblong, irregularly firm, nodular, and slightly tender mass in the right inguinal and femoral regions. The abdomen was distended and rigid, graded 2. The heart was normal in rate and rhythm, and the blood-pressure was 148 systolic and 100 diastolic. Leucocytes numbered 14,000 in each cubic millimetre of blood. A diagnosis of strangulated femoral hernia was made, and immediate operation advised.

Under general anæsthesia, the mass was explored through a vertical incision. The sac was freed by sectioning the falciform edge of the fascia which was producing the

STRANGULATED FEMORAL HERNIA

strangulation. The sac contained approximately forty centimetres of strangulated, gangrenous small intestine and a considerable amount of strangulated omentum. The omentum was firmly attached to the sac by old adhesions. The strangulated omentum was excised and removed. The gangrenous intestine was pulled from the hernial aperture and resected well beyond the devitalized portion. (Fig. 3.) The ends of the bowel were closed, and a side-to-side anastomosis was performed. The hernia was then repaired by suturing Gimbernat's ligament and the pectineus fascia to the lower edge of Poupart's ligament with interrupted sutures of No. 2 chromic catgut. Convalescence was not complicated.

According to Scarpa's⁵ observation, obstruction becomes complete only if two-thirds of the intestinal wall is constricted. Rhodes'⁴ recent study clearly proves that the type of hernia in which only part of the circumference is included (Richter's) is seen more commonly in females and occurs more frequently on the right side; also, that it is involved in femoral hernias more than in inguinal hernias. This type of hernia also becomes manifest in femoral hernias of long duration. This point is important since femoral hernias may exist for years without many symptoms. Early in life a femoral hernial sac is surrounded by a rather thick layer of adipose tissue which is designated the pre-peritoneal fat and is continuous with that adjacent to the bladder. After the fifth and sixth decades of life, and particularly in women following menopause, there is gradual but progressive atrophy of this protective fatty layer which is coincident with relaxation of the fascia of the abdominal wall. The peritoneal sac then may slowly increase in size, permitting intestine and omentum not only to enter more easily but to stretch farther into the femoral canal. The diameter of the femoral ring will be increased on account of these changing influences. If it is as large as in Case II, the hernia may reach an unusual size, which is rare, but it will then contain a large segment of intestine, usually ileum, and omentum; both will be strangulated due to the unyielding, sharp-edged fascia that forms the anterior wall of the femoral canal above, and the rigid Gimbernat's ligament, situated below and posteriorly. When a segment of ileum is suddenly thrust beyond these points of strangulation, the constriction of the bowel and mesentery is complete, and all the symptoms of acute intestinal obstruction, such as pain, vomiting, abdominal tenderness and collapse occur. The symptoms in this type of femoral hernia are more violent than in the Richter type. Autolysis of the mucosa of the strangulated intestine, and abnormal absorption through the mesenteric vessels, quickly occur. The pain is agonizing, and is associated with abdominal colic and marked hyperperistalsis. The tenderness, which is first over the mass, as in Case II, soon passes up over the abdomen with the advent of peritoneal irritation, abdominal tenderness, distention, rigidity, and rapid and feeble pulse.

The symptoms in the Richter type of hernia, especially early, depend entirely on the amount of the intestinal wall that is involved. There may be only a very small segment occluded which would induce only localized pain associated with some epigastric distress resulting from the pull on the

mesentery. The sensation of pulling is characteristic of the milder degree of obstruction. Nausea and vomiting, with increasing tenderness at the femoral ring, are factors which indicate that more of the lumen of the bowel is being occluded. Omentum, which is frequently included in the hernial contents, may offer some protection to the circulation of the bowel, thereby saving the wall from rapid necrosis.

Treatment is entirely surgical. It should be instituted early before the signs of strangulation become obvious if intestinal resection is to be avoided and if the mortality is to be reduced.

A vertical incision directly over the mass affords the best exposure. (Fig. 4.) The sac is reached immediately beneath the superficial fat and fascia, where its further isolation should be effected by blunt dissection. By placing the index fingers in the canal it can be stretched sufficiently to relax

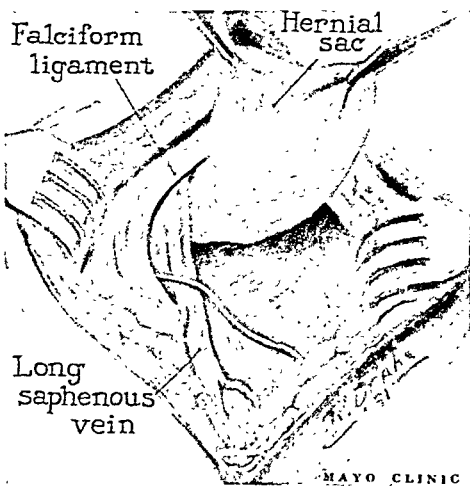


FIG. 4.

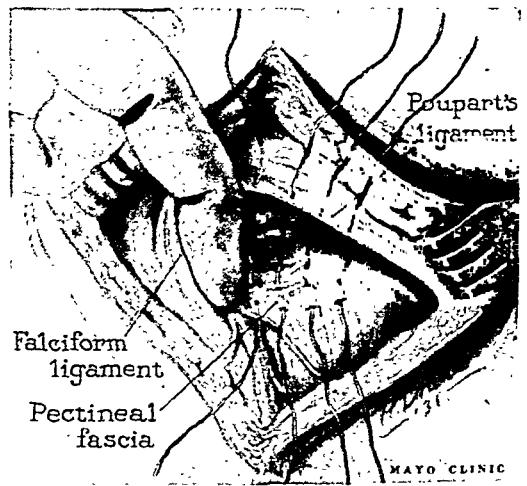


FIG. 5.

FIG. 4.—The hernial sac is exposed through a vertical incision. The falciform ligament has been partially sectioned above to increase the diameter of the femoral opening.
FIG. 5.—The interrupted sutures are in position and the femoral and long saphenous veins held laterally by the index finger.

the Richter type of hernia. In the large hernia containing a loop of bowel, it is advisable to section externally the falciform fascia with the Mayo type of scissors. The sac is opened and the bowel pulled out beyond the points of strangulation to determine whether the bowel is viable. If the normal color of the bowel, and pulsation in the vessels of the mesentery, return within a few minutes, it is safe to replace the bowel and quickly to repair the hernia. Otherwise, if this does not occur, it is necessary to resect the devitalized bowel well beyond the injured area either with an end-to-end or side-to-side anastomosis. If patients are very ill, it is often better to perform an exteriorization type of operation and then later an anastomosis. Better continuity of the bowel is obtained by the side-to-side type of anastomosis, since distention and hyperæmia of the proximal loop frequently render an end-to-end type unsafe. The larger opening secured through the former assures more complete drainage of the proximal loop. Extensive

STRANGULATED FEMORAL HERNIA

resection does not often become necessary in the Richter type on account of the fact that obstruction is incomplete and there is necrosis of only a portion of the circumference of the bowel. Here local excision of the necrosed portion and transverse closure of the opening will suffice. The bowel in this type may drop back into the abdomen when the sac is being separated, so that if it is not searched for and repaired, the necrosed portion will slough out and the contents of the small intestine pour into the peritoneal cavity.

The repair of the hernia is simple and easy to perform. After the sac is excised, the fascia of the pectineus muscle and the lower edge of Gimbernat's ligament are sutured to Poupart's ligament with No. 2 chromic catgut. As a rule, four sutures are sufficient to close the femoral opening. The danger of injuring the femoral vein by sticking or compressing it is obviated by retracting it with the index finger (Fig. 5) while placing the sutures. There should be sufficient room between the vein and the last suture to admit the index finger.

BIBLIOGRAPHY

- ¹ Coley, W. B.: Quoted by Stone, H. B.: Hernia. In: Lewis, Dean: Practice of Surgery, vol. vii, chap. 9, 79 pp., Hagerstown, Maryland, W. F. Prior Co., 1929.
- ² Fowler: Quoted by Rhodes.
- ³ Gibson, C. L.: A Study of One Thousand Operations for Acute Intestinal Obstruction and Gangrenous Hernia. ANNALS OF SURGERY, vol. xxxii, pp. 486-514, October, 1900.
- ⁴ Rhodes, R. L.: Partial Enterocoele; Richter's, Littre's Hernia. Trans. South. Surg. Assn., vol. xli, pp. 175-187, 1928.
- ⁵ Scarpa: Quoted by Rhodes.

STRANGULATED FEMORAL CYSTOCELE

By ANTHONY P. VASTOLA, M.D.

OF WATERBURY, CONN.

AMERICAN literature has not very often recorded the occurrence of the urinary bladder in a strangulated femoral hernia. The Mayo Clinic has never issued a report on it. Coley stated: "I am sure the condition is a very rare one." He did not mention this complication in a series of 8,589 hernias operated upon between 1890 and 1918. Neither did Hoguet observe the condition in 2,468 hernia operations. Moschowitz, Erdman, Gallie and Mathews have never encountered it. Bevan and Lyle have seen the condition but have never published their findings. It was therefore necessary to search the foreign literature for published cases; and it is the object of this article to present a résumé of their points of interest, to discuss the diagnosis and treatment of this rare surgical disease and to report two of my own cases.

Investigation has disclosed that the first two clinical cases of femoral hernias of the bladder were reported by De la Porte, in 1750. Then, according to Verdier, no other cases were reported until 1890, when Aue mentioned the case of a man operated upon by Tiling which was probably the first femoral cystocele observed at operation. It was not until 1901 that Tailhefer reported the first case of a strangulated femoral cystocele. The diagnosis was made during the course of the operation and to confirm his suspicion he deliberately incised the tumefaction.

The *anatomical structure* of a strangulated femoral cystocele is essentially similar to that of the uncomplicated kind. According to the relationship of the bladder to the peritoneum they are divided into: (a) Intraperitoneal, in which there is a complete hernia sac containing the bladder process. (b) Paraperitoneal, in which the herniated bladder process is covered on one surface only by peritoneum. (c) Extraperitoneal, in which the herniated portion of the bladder is neither engaged nor contiguous to a hernia sac. Such hernias may be primary or secondary; the primary are either extraperitoneal or paraperitoneal, while the secondary are intraperitoneal or paraperitoneal. The ten previously published cases consisted of three of each type, and one case of a diverticulum which was unclassified. To these may be added my two cases: Case I, a diverticulum which, excepting Forques', is the only case published of a bladder diverticulum in a strangulated femoral hernia; and Case II, an extraperitoneal hernia of the bladder. Alesandri believes that it is very difficult to determine whether the herniated portion of the bladder, in doubtful cases, is really a diverticulum or whether it has assumed the form of a diverticulum since the herniation; it is obvious that this differentiation is even more difficult when the hernia becomes strangulated.

STRANGULATED FEMORAL CYSTOCELE

The *etiology* of strangulated femoral vesical hernias is a varied one. In regard to age all writers seem to agree that the condition appears nearly always during adult life and particularly in older people. Previous vesical affections seem to be a contributory factor in the production of the condition; also in women previous pregnancies and the presence of uterine or other pelvic tumors. Muscular effort, which is often mentioned in connection with the strangulation of ordinary hernias, is infrequently recorded in cases of strangulated vesical hernias. In three of the ten cases previously described in the literature, a cough precipitated the complication in two; a slight muscular exertion caused it in two others and in three no muscular effort was mentioned. My two patients were at absolute rest when the strangulation occurred. But repeated and continued exertion during urination is almost constant; prostatic enlargements or urethral strictures are often present. Jaboulay and Villard emphasize the fact that the same cause which brings about the distention of the bladder also provokes muscular effort, which is due to difficult urination.

The *symptoms* of a strangulated femoral cystocele are neither characteristic nor constant. Its clinical picture is very often a bizarre one; it necessarily varies according to what structures or organs are strangulated with the bladder. A careful history will disclose that in the majority of cases the hernia was irreducible for a long time previous to its strangulation and that the mass diminished in size and felt doughy after urination.

Urinary symptoms are not always present, but when present they are masked by gastro-intestinal symptoms which are usually of a reflex type. Only three of the cited cases had difficult or painful micturition either just before or after the strangulation; the remaining cases had no urinary symptoms. In the two cases which I have appended, Case II had genito-urinary symptoms which simulated closely a renal colic. In my opinion the severity of symptoms referable to the urinary tract is dependent directly upon the proximity of the ureter to the strangulated portion of the bladder. Obviously, if the ureteral orifice is involved in the strangulation, all the classical symptoms of a renal obstruction will be present, together with the reflex gastro-intestinal symptoms which are usually associated with an obstructive lesion of the renal tract. In contrast to the severity of the symptoms presented by my second patient, Case I had only those urinary symptoms which one expects to see in a patient with a prostatic enlargement.

Disturbances of the gastro-intestinal tract in the form of abdominal distention, pain, nausea, vomiting and obstruction when present may be due directly to a concomitant strangulation of the intestine, or they may be entirely reflex in character. Four of the six cases described, which had nausea and vomiting, also had symptoms of an intestinal obstruction, although the operation did not disclose a strangulated intestine, and in one of these cases there was no hernia sac found. In my second case the history elicited the fact that his attack had started with painful and difficult urination, but

his gastro-intestinal symptoms were so dominant that a diagnosis of intestinal obstruction was made in spite of the presence of hæmorrhagic urine.

The diagnosis of a strangulated femoral cystocele, in the absence of urinary symptoms, is a very difficult one. Of the ten cases reported and the author's two, none was diagnosed before the operation; eight were diagnosed during the course of the operation and four after the bladder was cut. If with the history of an irreducible femoral hernia the patient has the urinary symptoms enumerated; and if a cystoscopical examination should show a vesical defect on the side of the hernia, which is confirmed by cystography, the diagnosis of a strangulated femoral cystocele becomes a positive one.

Treatment.—Shock which is invariably present must be combated. Before resorting to surgery the bladder must be catheterized and the bowels evacuated by an enema. In addition it is advisable to apply heat to the mass and to give a hypodermic injection of morphine. An attempt to reduce the mass is then made, and if it fails the patient is informed that an operation is imperative.

The anæsthesia of choice is spinal or local. To expose the mass an incision below and parallel to Poupart's ligament is made. The hernia sac if present should be carefully examined to determine its relation to the strangulated bladder. When the bladder is intraperitoneal and adherent to the interior of the sac or to the omentum, it is carefully dissected free and reduced into the peritoneal cavity.

In a paraperitoneal bladder hernia the treatment will vary according to the size of the bladder hernia and its relation to the sac. A small hernia is separated from the peritoneal sac by gauze dissection and invaginated through the femoral ring and so reduced. No attempt should be made to strip off a large peritoneal sac which covers a considerable portion of the bladder; instead, an excision is performed around the inner side of the peritoneal sac so as to leave its medial portion intact with the bladder, and the latter reduced.

The bladder in an extraperitoneal hernia may be mistaken for the peritoneal sac and incised. If this is done the bladder should be immediately sutured with a through-and-through continuous suture of catgut and reinforced by a second Lembert catgut suture.

In either of the three types of bladder hernias, after the bladder is reduced, the peritoneal sac is transfixed high up in the femoral ring and excised. This is followed by one of the usual methods of closing the femoral ring. But if the strangulated portion of the bladder consists of an intraperitoneal diverticulum, there might be danger of sloughing with leakage of urine and peritonitis if the bladder were closed tight and a radical repair of the hernia performed; under these circumstances the procedure should be that employed in my first case.

The patient is made more comfortable and bladder tension is relieved by inserting in the bladder a retention catheter and permitting it to remain in place for at least ten days. If, unfortunately, during the operation the

STRANGULATED FEMORAL CYSTOCELE

bladder is cut, it is advisable to drain the wound with a small cigarette drain for a few days.

CASE REPORTS

CASE I.—G. P., aged seventy years, was admitted to St. Mary's Hospital at 9:50 P.M., September 1, 1928. Seen on entrance in consultation with Dr. J. H. McGrath. His chief complaint was a generalized abdominal pain, which began twenty-four hours previously in the right lower quadrant, and was accompanied by nausea and vomiting. He had no previous serious illness or abdominal disturbances, although for the past four years he had noticed an increasing frequency and difficulty in urination. He was in great pain, as he lay in bed with knees flexed. The abdomen was rigid and somewhat scaphoid in appearance, and palpation elicited a tenderness which was generalized but most

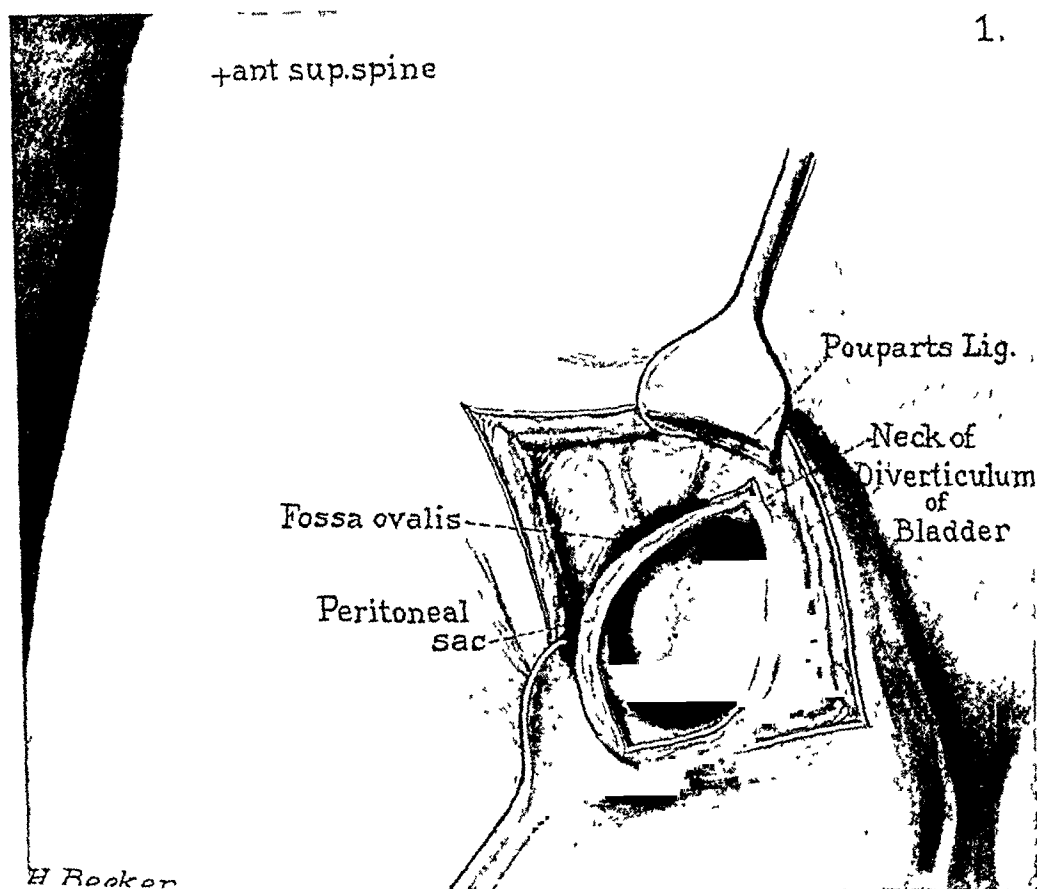


FIG. 1.—Hernia sac opened and showing its contents: a diverticulum of the urinary bladder.

intense in the right lower quadrant. His liver and spleen were not enlarged. The temperature was 103° F., pulse 109, and respiration 24 to the minute.

Since the sequence of his symptoms, the physical examination and blood-picture pointed to a typical case of acute suppurative appendicitis, a more thorough examination of his genito-urinary tract and hernia regions was not made.

Operation at 11:45 P.M., I removed, through a right rectus incision, an acute suppurating appendix. He reacted well from the operation and had no unusual symptoms until September 4, when, at 2:00 P.M., he complained of a sudden excruciating pain in the right femoral region. He stated that he had had a swelling in the right femoral region for twenty years, and that it had never caused him any discomfort. Examination disclosed in the right femoral region a very painful, irreducible mass about two inches in diameter. It was tense, it gave no impulse on coughing, could not be compressed, was dull to percussion and, apart from a slightly distended and painful abdomen, it was not associated with any symptoms referable to the genito-urinary and gastro-intestinal

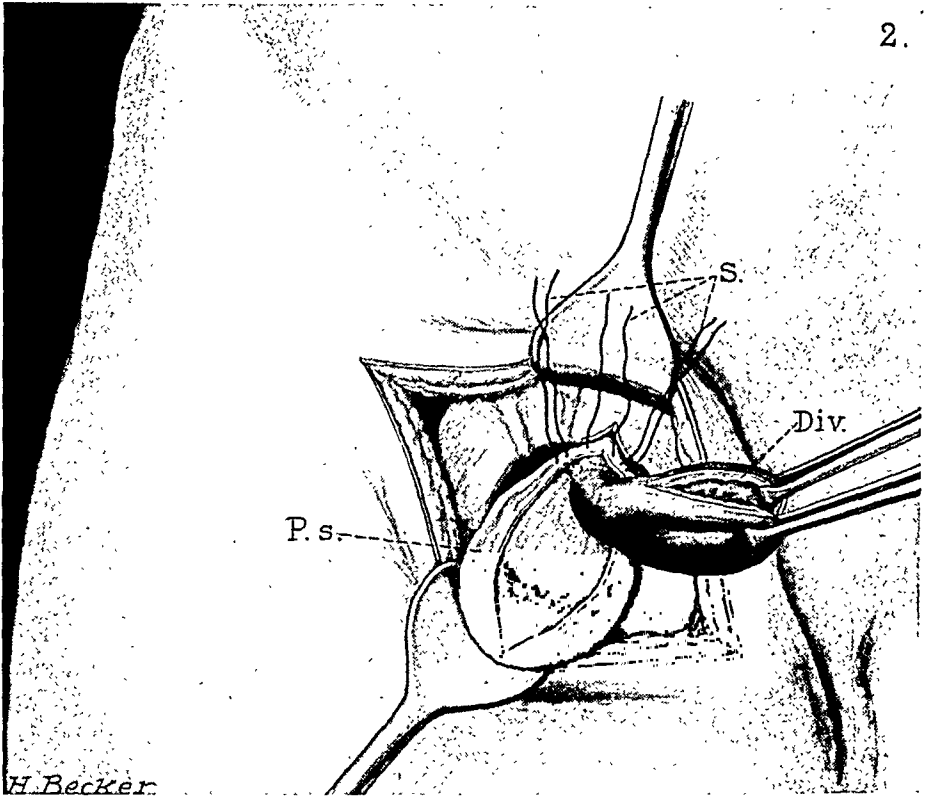


FIG. 2.—After the structure in the hernia sac had been identified the neck of the bladder diverticulum was pulled down and sutured high up to the interior of the neck of the peritoneal sac by interrupted catgut sutures.

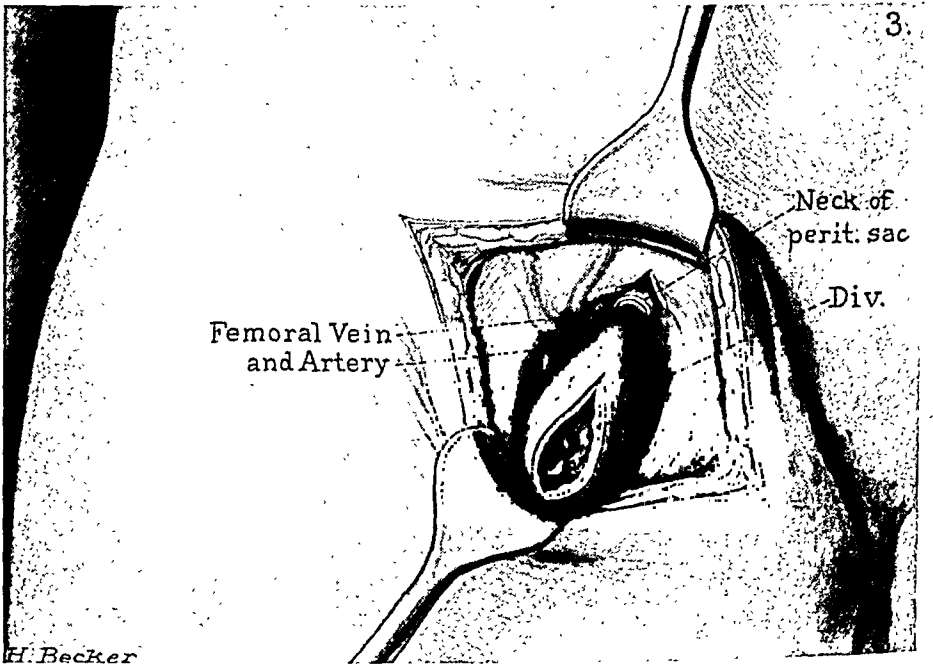


FIG. 3.—The peritoneal sac was excised, and the skin loosely brought together with silk worm-gut sutures around the diverticulum. Drains were inserted in the lower angle of the wound.

STRANGULATED FEMORAL CYSTOCELE

tracts. An enema was given and the patient expelled a light brown liquid stool which gave him relief but it had no effect on the femoral mass. The impression given was that he had a strangulated right femoral hernia which contained an incarcerated loop of intestine.

Operation September 4 at 4:00 P.M., under local anæsthesia with a 2 per cent. neo-caine solution, an incision parallel with Poupart's ligament and over the mass was made. A tense, congested sac was exposed, through the transparent walls of which could be seen a serosanguineous fluid. The constricting femoral ring was incised upwards sufficiently to relieve the strangulation, and the sac was then opened and evacuated of its hæmorrhagic fluid.

The content of the sac was a pear-shaped, thick, muscular, purplish structure which did not conform to anything I had ever seen before in a hernia sac. Digital examination and traction disclosed that its neck came from behind the pubis and as it lacked a mesentery it occurred to me that it might be a bladder diverticulum. It was accordingly

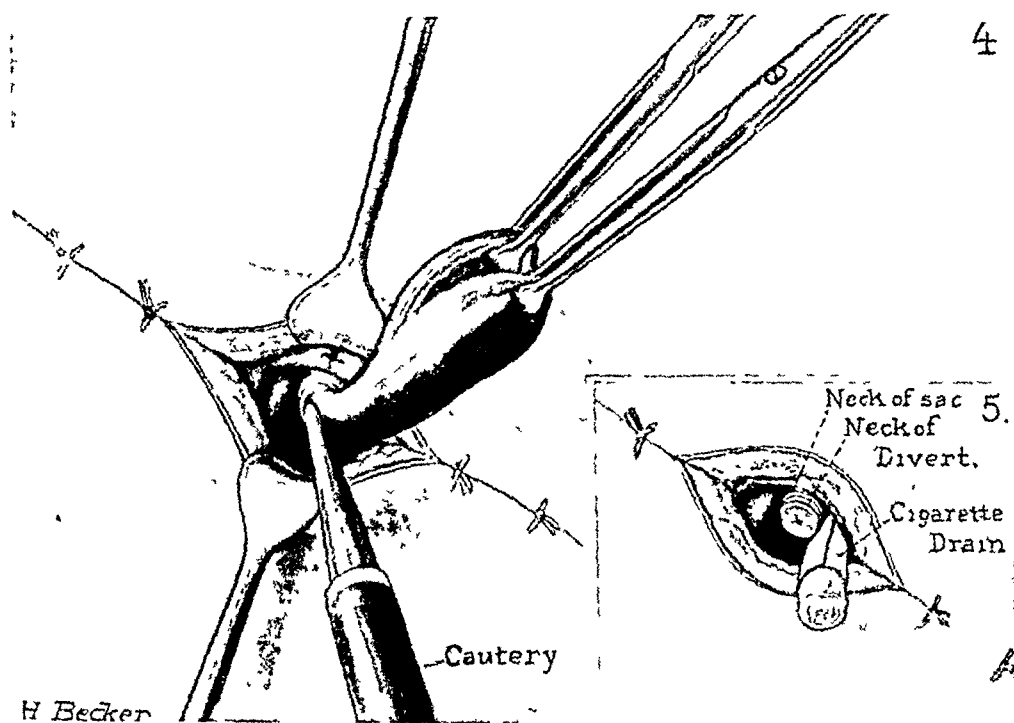


FIG. 4.—Four days later the distal portion of the diverticulum was extirpated with a Paquelin cautery.

FIG. 5.—Shows the neck of the diverticulum with its cuff of peritoneum, and drain in the lower angle of the wound

opened and my suspicion was confirmed by the escape of a small amount of yellow fluid; the index finger was then gently guided towards the mid-line behind the pubis and into the bladder.

The neck of this diverticulum was pulled down and attached by interrupted sutures around the interior of the hernia sac as high up in the femoral ring as possible, thus closing it off from the peritoneal cavity. The remaining portion of the hernia sac was then excised, and the skin loosely brought together with silkworm gut sutures, leaving the bladder diverticulum protruding from the wound, in the lower angle of which was inserted a cigarette drain. Four days later the portion of the diverticulum distal to the femoral ring was extirpated with a Paquelin cautery, and the opening in the bladder permitted to close in. It drained a diminishing amount of urine for ten days. On September 30, twenty-six days after the second operation, the patient was discharged from the hospital with both wounds healed and with a cure of his femoral hernia.

CASE II.—F. P., a man, aged fifty-nine years, was seen by me on May 9, 1932, at 8:30 P.M. It was stated that the man, while reading, had felt a peculiar burning sensa-

tion in his urethra which was accompanied by a desire to urinate. This feeling disappeared and recurred several times within a period of twenty minutes. It was followed by a severe chill and a sharp pain in the right lumbar region which radiated down his right ureter and then became localized over the right femoral region. His bowels had moved well that morning, and up to the present illness he had never experienced any similar attacks.

Thirty years ago he first noticed a swelling which was diagnosed as a right femoral hernia, and which was never completely reducible. During 1925, he suffered from severe attacks of dizziness, nausea and vomiting and was informed that he had Meniere's disease. In 1926, a tonsillectomy and the following year an appendectomy and a cholecystectomy were performed upon him. He denied any venereal infection, nor did he up to the present illness, have any symptoms referable to his genito-urinary tract. He had always suffered from low back pain and constipation.

When first seen by me he was in bed with knees flexed, and was vomiting. His expression, as he held his distended abdomen with both hands, denoted intense pain. Temperature was 97° F., by mouth, pulse 120 to the minute. In his right femoral region was a swelling about three and one-half inches in size, painful to palpation and dull to percussion. The outer portion of this swelling was slightly distended and irreducible; the medial half could be made to disappear by gentle and steady compression and as it diminished in size a soft irreducible mass could be felt. When the pressure was released the tumefaction slowly reappeared and with it an agonizing pain.

As the patient's general condition denoted a moderate degree of shock he was surrounded with hot-water bags and given a hypodermic injection of morphine sulphate gr. \overline{ss} . After the pain had subsided he was given a soap-sud enema which was not effectual. A second attempt to reduce the femoral hernia was made but again was unsuccessful. The impression made was that the man had a strangulated right femoral hernia.

Operation May 10 at 1:30 A.M., under spinal anæsthesia with neocaine, an incision slightly below and parallel with Poupart's ligament and through the superficial fascia exposed the lower two-thirds of that ligament. Dissection extending along the line of incision below Poupart's ligament exposed the femoral mass protruding from the constricted femoral ring, which was incised. The area above Poupart's was cleared of its adipose tissue, uncovering the aponeurosis of the external oblique, the external abdominal ring and spermatic cord. A dissection along the lateral side of the mass exposed the hernia sac, which had on its medial side an unusual amount of what at first appeared to be tenaciously adherent fat. The hernia sac, about one and one-half inches in length, did not appear to be acutely congested; when opened it was found to be empty. It was then grasped together with the fat adherent to its medial side by an artery clamp; the conjoined tendon and the cord were retracted medially and the artery clamp which grasped the hernia mass was thrust underneath Poupart's ligament and the exposed floor of Hesselbach's triangle. An incision was then made in the transversalis fascia pushed up by the artery clamp, and the hernia sac was drawn through the opening. An excision with scissors of the fat still adherent to the medial side of the sac was begun when an opening about two inches in length was made into a muscular hollow organ which was identified as the bladder. It was immediately sutured with a continuous through-and-through interlocking stitch of No. 2 chromic catgut and reinforced by a second continuous Lembert stitch. The hernia sac was transfixated with a needle and plain catgut and followed by the closure of the femoral ring with two interrupted chromic catgut sutures, approximating Poupart's ligament to Gimbernat's ligament and the pectineal fascia. A cigarette drain was inserted at the lower angle of the wound and the incision closed by interrupted silkworm gut sutures, following which a retention catheter was inserted in the bladder and allowed to remain in place for ten days. The post-operative course, apart from blood appearing in the urine for seventy-two hours,

STRANGULATED FEMORAL CYSTOCELE

was uneventful; there was no leakage of urine from the wound and the patient was discharged from the hospital sixteen days after the operation.

Summary.—Strangulated femoral cystocele is rare and in 100 per cent. of the reported cases the pre-operative diagnosis was incorrect. When the strangulation of an old irreducible femoral hernia is associated with spasmodic pain over the mass which radiates to the pubic region, along the urethra and to the lumbar region, and when these symptoms are accompanied by difficult, frequent, painful and hæmorrhagic urination, the presence of a strangulated bladder should be kept in mind. The diagnosis can be confirmed by cystography. Ten cases of strangulated femoral cystocele previously recorded have been reviewed, and two additional cases have been described.

REPORTED CASES OF STRANGULATED FEMORAL CYSTOCELE

CASE I.—(Abadie.) Female, aged twenty-six years; left side. Gastro-intestinal Symptoms.—Nausea and vomiting. Genito-urinary Symptoms.—None. No diagnosis made pre-operatively; made during operation. Type.—Para.* Other structures strangulated with bladder—none. Bladder cut. Recovered.

CASE II.—(Baricci.) Female, aged forty-three years; right side. Gastro-intestinal Symptoms.—Nausea and vomiting. Genito-urinary Symptoms.—Frequent, painful, and difficult urination. No diagnosis made pre-operatively; made during operation. Type.—Extra.† Other structures strangulated with bladder—right Fallopian tube. Recovered.

CASE III.—(Laskownicki.) Female, aged sixty-five years; right side. Gastro-intestinal Symptoms.—Nausea, vomiting, tympanitis, no bowel movements. Genito-urinary Symptoms.—None. No diagnosis made pre-operatively; made during operation. Type.—Para.* Other structures strangulated with bladder—none. Bladder cut. Recovered.

CASE IV.—(Tailhefer.) Female, aged sixty-one years; right side. Gastro-intestinal Symptoms.—Nausea, vomiting of fecaloid material, inability to evacuate bowels or pass gas. Genito-urinary Symptoms.—Frequent, painful and difficult urination. No diagnosis made pre-operatively; made during operation. Type.—Para.* Other structures strangulated with bladder—none. Bladder cut. Recovered.

CASE V.—(Dardinelli.) Female, aged fifty-two years; right side. Gastro-intestinal Symptoms.—Absent. Genito-urinary Symptoms.—Frequent and painful urination. No diagnosis made pre-operatively; made during operation. Type.—Extra.† Other structures strangulated with bladder—right Fallopian tube. Recovered.

CASE VI.—(Oliva.) Male, aged eight years; right side. Gastro-intestinal Symptoms.—Nausea and vomiting. Genito-urinary Symptoms.—None. No diagnosis made pre-operatively; made during operation. Type.—Extra.† Other structures strangulated with bladder—none. Recovered.

CASE VII.—(Wakeley.) Female, aged thirty-eight years; right side. Gastro-intestinal Symptoms.—None mentioned. Genito-urinary Symptoms.—None mentioned. No diagnosis made pre-operatively; made during operation. Type.—Intra.‡ Other structures strangulated with bladder—intestine. Bladder cut. Died.

CASE VIII.—(Wakeley.) Female, aged seventy-two years; right side. Gastro-intestinal Symptoms.—None mentioned. Genito-urinary Symptoms.—None mentioned. No diagnosis made pre-operatively; made during operation. Type.—Intra.‡ Other structures strangulated with bladder—omentum. Recovered.

CASE IX.—(Zintzmaster.) Male, aged fifty-four years; not stated which side. Gastro-intestinal Symptoms.—Absent. Genito-urinary Symptoms.—None mentioned. No diagnosis made pre-operatively; made during operation. Type.—Intra.‡ Other structures strangulated with bladder—none. Bladder cut. Recovered.

CASE X.—(Forques.) Male, aged seventy-two years; not stated which side. Gastro-intestinal Symptoms.—Fecaloid vomiting; inability to evacuate bowels or expel gas. Genito-urinary Symptoms.—None. No diagnosis made pre-operatively; made during operation. Type.—Not stated. Other structures strangulated with bladder—none. Recovered.

Totals.—Females, 7; males, 3; right side, 7; left side, 1; not stated, 2. Intestinal symptoms present, 6; absent, 2; not mentioned, 2. Urinary symptoms present, 3; absent, 4; not mentioned, 3. Correct Diagnosis.—None. Diagnosis made during operation, 10. Type.—Para,* 3; extra,† 3; intra,‡ 3; not stated, 1. Other structures involved, 4; bladder only, 6. Bladder cut, 5; not cut, 5. Recovered, 9; died, 1.

* Para—paraperitoneal.

† Extra—extraperitoneal.

‡ Intra—intraperitoneal.

BIBLIOGRAPHY

- Abadie: Strangulated Femoral Cystocele. *Bull. et mem. Soc., anat. de Par.*, 6th ser., vol. vii, pp. 617-619, 1905.
- Alessandri, R.: Pathogenesis of Hernia of Bladder. *Policlin.*, vol. viii, pp. 1-61, 1901.
- Baricci, P.: Case of Strangulated Tubo-vesical Femoral Hernia.
- Bevan, A. D.: Personal Communication.
- Bumpus, H. C.: Personal Communication.
- Cheever, D.: Personal Communication.
- Dardinelli, M.: Strangulated Right Femoral Hernia Containing Fallopian Tube and Bladder; Pathogenesis and Mechanism of Strangulation. *Riforma med.*, vol. xxvi, pp. 208-212, 1910.
- Erdman, J. F.: Personal Communication.
- Gallie, W. E.: Personal Communication.
- Heyd, C. G.: Personal Communication.
- Homans, J.: Personal Communication.
- Horsley, J. S.: Personal Communication.
- Laskownicki, S.: Incarceration of Bladder in Crural Ring. *J. d'urol.*, vol. xviii, pp. 251-253, 1924.
- Lahey, F. H.: Personal Communication.
- LaRoque, R.: Personal Communication.
- Lyle, H. M.: Personal Communication.
- Moschowitz, A. V.: Personal Communication.
- Tailhefer, E.: Strangulation of Femoral Cystocele; Fecaloid Vomiting. *Proc. verb.*, 14th Cong., *Franc. de chir., Par.*, vol. xvi, pp. 583-586, 1901.
- Wakeley, C. P. G.: Etiology and Treatment of Bladder Hernia; Forty Cases. *Brit. Jour. Urol.*, vol. ii, pp. 1-14, 1930.
- Zintzmaster, L. B.: Cases of Strangulated Femoral Hernia, Including Part of Bladder. *Ohio Med. Jour.*, vol. ix, p. 407, 1913.

OSTEOMYELITIS OF THE SKULL *

BY IRA COHEN, M.D.

OF NEW YORK, N. Y.

FROM THE SURGICAL SERVICES OF THE MOUNT SINAI AND THE MONTEFIORE HOSPITALS

EXCEPTING a paper by Fleming,⁶ the recent literature on osteomyelitis of the skull is largely devoted to a discussion of instances complicating infections of the contiguous nasal sinuses. Fleming's paper deals with the post traumatic variety, only one of his eight cases having followed a sinus infection. Reports on the nasal sinus type of infection were collected by Lemere, 1923⁸; Bulson, 1925⁵; McKenzie, 1927⁹; and Munro, 1930.¹⁰ McKenzie published a paper in 1913⁹ which is the most detailed study written in English up to that time. He refers to a paper by Schilling¹¹ in which not only cases of sinus but also those of traumatic origin are discussed. Schilling points out that metastatic osteomyelitis of the skull secondary to a primary focus elsewhere in the body is rare (he refers to six reported cases), while the still greater rarity of a primary acute involvement of the skull such as is seen in the long bones is emphasized. He quotes one such primary case reported by Fischer,⁷ and mentions two reported by Bergmann.¹

This paper is based on thirteen cases of osteomyelitis involving the vault of the skull. Of these, seven cases followed infection about the nasal sinuses; two were metastatic; two may be classified as traumatic; in two the etiology was undetermined, and they may possibly be termed primary.

In six of the seven cases in which the osteomyelitis was secondary to infection in the nasal sinuses, a radical external operation had been done by a rhinologist before the patient came under my observation.

CASE I.—Following an operation on the nose and a tooth extraction an extensive osteomyelitis of the frontal bone developed. This progressed up to the patient's death.

(Mt. Sinai Hospital No. 299551.) M. G., male, aged forty-four years, had a plastic operation on his nose three weeks prior to the onset of his present trouble. At the same time he had an abscessed tooth extracted from the right upper jaw, and claimed the cavity was irrigated through the nose. An abscess formed and was incised just below the right eye. Three weeks later another abscess was incised about the bridge of the nose, and after another three-week period a third abscess formed and was opened over the right frontal region. Drainage persisted from the first and third incisions. For several weeks he had had headache severe enough to keep him in bed most of the time. Four months after the nasal plastic and tooth extraction he entered the hospital. He denied having any fever or chills. He presented a discharging sinus over the right maxillary eminence and one in the right eyebrow. There was a cold, soft swelling over the left frontal eminence, pressure on which caused pus to flow from the sinus in the right eyebrow. In his nose there were signs of a suppurative left ethmoiditis. His general and neurological examinations were negative, as were his fundi.

February 15 at operation Doctor Kramer found the nasal process of the frontal bones sequestered and the outer and posterior walls of both frontal sinuses absent

* Read before the New York Surgical Society, October 31, 1932.

(either removed or sequestered). The frontal bones were diseased for a distance of one and one-quarter inches from the mid-line and for four inches toward the coronal suture. The inner table of the skull was more diseased than the outer and the dura was covered with granulations.

The headache persisted, there were some personality changes, and three weeks after this operation he was transferred from the rhinolaryngological service to the surgical service, when it was noted that the deep reflexes on the left were a trifle more active than those on the right. At this time a beginning neuritis was noted in the right optic nerve. The signs were too meagre to warrant a diagnosis of brain abscess and the

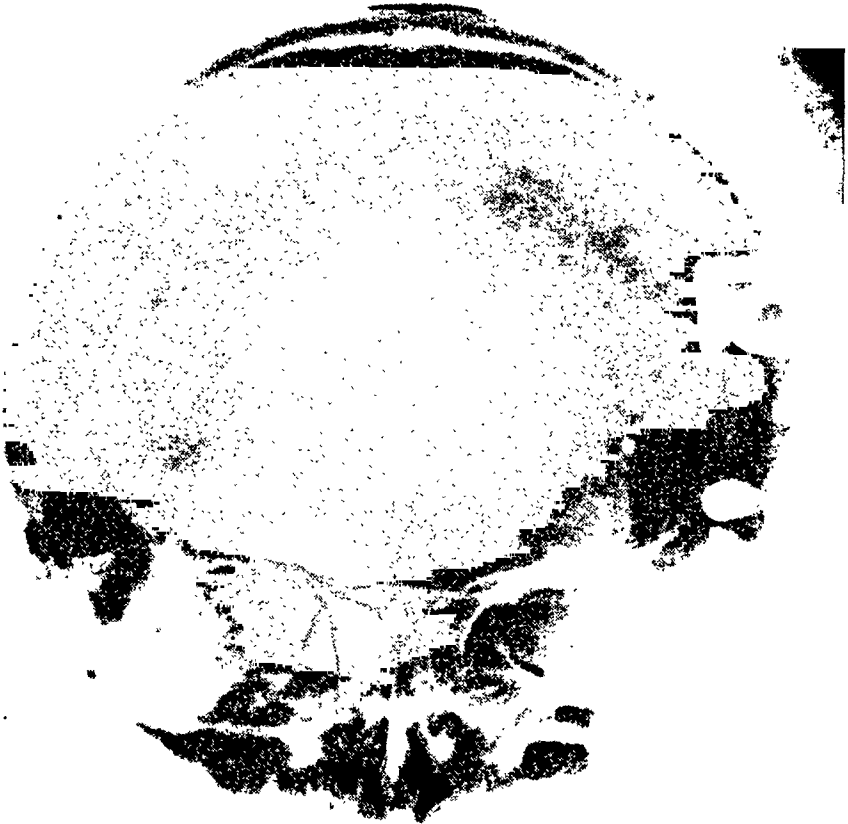


FIG. 1.—(Case I.) Röntgen appearance of skull after removal of large sequestrum of frontal bone.

patient was observed further. March 18 an abscess of the scalp to the right of the mid-line was opened and April 10 one to the left. The latter showed a small perforation through both tables. April 14 the incision on the right was extended to evacuate another pocket. The following day, through a trephine opening in a clean area on the right side, the brain was explored for an abscess. None was found nor was the brain under any increased pressure. A week later a lumbar puncture gave clear fluid under normal pressure. It contained four cells and no bacteria on spread or culture. April 30 the patient was very drowsy and the pulse rate had fallen to 60. By extending previous incisions on the right and left a sequestrum four by two and one-half inches was removed from the frontal bones. Granulation tissue but no pus was found beneath it. The dura was covered with granulations. After iodine had been applied to the dura

OSTEOMYELITIS OF SKULL

both frontal lobes were explored with a needle but no abscess found. The patient continued in stupor and died the following day. No necropsy was permitted. The pus from the various abscesses contained a *Staphylococcus aureus*. The röntgen appearance of the skull is seen in Fig. 1.

It cannot be definitely stated whether the plastic operation on the nose or the infected tooth was the starting point for the infection. The tooth was probably at fault as it was infected. Moreover, the first abscess appeared over the malar eminence which would not be the case were it a nasal infection. Without a post-mortem examination the exact cause of death cannot be stated. A brain abscess was probably ruled out by



FIG. 2—(Case II.) Osteomyelitis mostly confined to right frontal.

the two explorations. A localized basilar meningeal infection may have been the terminal factor.

CASE II.—*Orbital abscess following ethmoid infection.* Positive blood culture. Osteomyelitis of skull. Recovery.

(Mount Sinai Hospital No. 269632.) A boy of five was admitted to the rhinolaryngological service July 20, 1926, because of swelling of the right orbit. This was of one day's duration and had come on following a rhinitis. The boy was very sick with a temperature which remained rather constantly around 103° for nearly two weeks. On one occasion it rose to 108° . Three external operations for a perforated ethmoidal infection and an orbital abscess were done during this period. A blood culture was

reported to contain *Staphylococcus aureus*. The pus from the orbital abscess contained the same organism with a *Staphylococcus albus*. A lumbar puncture disclosed clear fluid under increased pressure. A month after his admission tenderness developed over the right frontal area and an X-ray was suggestive of osteomyelitis of the frontal bone. (Fig. 2.) Two days later (August 27) an abscess was drained over the right frontal eminence. An erosion of about one centimetre of the outer table and somewhat less of the inner table was found. The necrotic bone was removed. Eighteen days later a second abscess near the coronal suture and more mesially was drained. The bone was found eroded to the dura, which appeared normal. Six weeks later a third incision was made between the other two and a small erosion of the outer table only was found. Two weeks later the boy was discharged with draining sinuses to the out-patient department to receive heliotherapy. A year later an abscess formed in the right upper eyelid. This opened spontaneously. It did not lead to exposed bone. X-ray failed to show a sequestrum or extension of the disease. The scalp wounds had healed. He was seen four months later with wounds healed and symptom-free.

This is the only patient in whom a positive blood culture was found. The signs of osteomyelitis of the skull were not manifest until more than a month after the onset of the illness. McKenzie distinguishes between an osteomyelitis that develops with the sinus infection and an osteomyelitis as a post-operative complication.

CASE III.—An infant who entered the hospital with an osteomyelitis of the frontal bone developed a frontal lobe abscess and died after the drainage of this abscess.

(Mount Sinai Hospital No. 298910.) January 21, 1929, a nine-months-old infant was admitted to the hospital with a history that seventeen weeks previously she had had "a cold" for one day. The following day a swelling appeared over the right eye and her temperature rose to 105°. Following an incision in the right upper eyelid pus drained for three weeks. During this time the child developed pneumonia. A week after the incision in the eyelid stopped draining a swelling appeared over the right frontal region. For four weeks prior to admission there had been daily vomiting and for four days weakness of the left arm and leg. Examination showed a swelling in the right frontal region, a discharging sinus in the right eyelid, a left hemiparesis and normal fundi. The spinal fluid contained ninety cells, all lymphocytes.

January 24 an incision was made over the fluctuant mass on the forehead. After evacuating a few drops of pus several eroded areas were noted and in one of these a sequestrum was found. No pus was found between the bone and the dura. The entire exposed area was cleaned with tincture of iodine and the dura opened. The brain bulged into the opening but aspiration failed to find an abscess. Twelve days later a second abscess above and to the right of the first one was incised, and the previous operative site was revised. Sequestra were found in both situations. The temperature varied from 102° to 104°. February 23 a suppurative cervical adenitis was incised. The hemiparesis meanwhile improved. March 18 there was a rise in temperature to 104.2° and the child became stuporous. The right pupil was dilated and fixed; the left pupil was normal in size and fixed; the left arm and leg were moved freely. There was a bulge at the operative site which when aspirated disclosed pus. At operation a thick walled brain abscess was found at a depth of four centimetres and was drained by a tube. Following this the temperature rose to 107.8° and the child died. The pus from the brain abscess as well as that obtained from the superficial abscess contained *Staphylococcus aureus*. X-ray examination of the skull showed multiple areas of diminished density suggestive of an osteomyelitis. The post-mortem examination showed pus in the right ethmoid sinus, a drained right frontal lobe abscess with extensive area of softening about the abscess.

It is probable that the frontal lobe abscess was present but missed at the first search.

CASE IV.—*Perforated frontal sinusitis*. Osteomyelitis of skull. Frontal lobe abscess. Recovery.

(Mount Sinai Hospital No. 299325.) A man, thirty-seven years old, was admitted

OSTEOMYELITIS OF SKULL

to the rhinolaryngological service February 3, 1929, with the history that for eight days he had headache and swelling about the right eye. These symptoms appeared two days after the onset of a cold. He had a temperature of 102.4° with a pulse of 72. There were œdema and redness about the right eye which was proptosed. Some œdema was present over the forehead above the orbital ridge. The eye moved with difficulty. Pus was seen in the nose. On the day of admission Doctor Kramer did a radical external ethmoid operation. Eleven days afterward abscesses were drained over the right and left frontal region. Meanwhile there developed slight papilloœdema and some left facial weakness. An epidural or brain abscess was suspected. February 23 Doctor Kramer



FIG 3—(Case IV) Extent of involvement of frontal bones

did a radical frontal operation and found necrosis of the floor and the posterior wall. There was an epidural collection of pus and a sinus track leading down to a frontal lobe abscess which was drained. Two weeks later the patient was transferred to the surgical service and the following day abscesses were opened over both right and left frontal regions, revealing eroded bone. On the left side there was a sequestrum and an epidural abscess. A large hernia cerebri developed in the right frontal incision and a cerebrospinal fluid leak occurred. A month after the frontal sinus operation, the patient developed a rigid neck and showed 3500 cells in his cerebrospinal fluid. These manifestations gradually cleared up. The hernia receded in part with some necrosis of the surface. A month later an osteomyelitic focus was drained near the mid-line anteriorly

and a second one over the occiput. These contained sequestra. In the next ten days there was considerable improvement and on June 2, four months after admission, the patient was discharged with three granulating sinuses of the forehead. Except for two shoots of temperature to 103° and 104° during this illness, the temperature did not arise above 101° . The pus from all abscesses and the sinus contained *Staphylococcus aureus*. X-ray of the skull is shown in Fig. 3. The patient still had (two years later) two small draining sinuses in the frontal region leading to exposed bone.

The infection in this case was a virulent one. The bone involvement was practically concomitant with the sinus infection. There was evidence of an osteomyelitis of the frontal bone at a considerable distance from the frontal sinus even before the operation on the sinus. The epidural abscess behind the posterior wall of the frontal sinus communicated directly with the frontal lobe abscess.

CASE V.—*Acute frontal sinus infection*. Osteomyelitis of the frontal bone. Brain abscess. Drainage. Recovery.

(Mount Sinai Hospital No. 301267.) A boy sixteen years old was admitted to the rhinolaryngological service April 18, 1929, with a history of persistent headache for four weeks and swelling of the forehead for three and one-half weeks. These symptoms followed a cold. During the four-week period he had had two chills and his temperature had risen to 104° . He vomited the day of admission. On examination tenderness was found over the left frontal sinus and over the left frontal bone just about the hair line. The deep reflexes on the right were more active than those on the left. The fundi were normal. April 18 Doctor Kramer performed an external operation on the left frontal sinus; finding disease of the sinus and roughening of the posterior wall. When a small piece of the latter was removed normal dura was exposed. During the next ten days the boy was drowsy, complained at times of headache, and had a bradycardia. On the tenth day one diopter swelling of the optic discs was noted and the patient was transferred to the surgical service. The following day an abscess in the scalp just above the hair line and to the left of the median line was incised. This communicated with a perforation in the bone, and on removing more bone pus was seen coming from a pinpoint opening in the dura. This opening was enlarged and a drainage tube was placed into an abscess in the left frontal lobe. At the time of operation it could not be stated whether the tube had been placed into an intra- or extracerebral abscess. The introduction of iodized oil through the tube and X-ray studies proved the abscess to be intracerebral. (Fig. 4.) Following the drainage of the abscess there was an increase in the papilloedema for a few weeks. The patient was discharged from the hospital three months after operation. The pus from the frontal sinus and from the brain abscess grew a streptococcus. The patient was seen two years later at which time he was symptom-free and showed no neurological signs.

A single limited bone focus characterized the osteomyelitis in this case. The brain abscess lay directly beneath this diseased area and communicated with it. The exact location of the drainage tube was made certain by the use of X-ray with iodized oil. We have on several previous occasions made use of this method to determine whether a brain abscess was draining properly.

In 1920, Bryan⁴ described the use of thorium nitrate as a contrast medium to determine whether an abscess he had drained was intra- or extracerebral.

CASE VI.—*Acute frontal sinusitis, extensive osteomyelitis of skull*. Death. Post-mortem—brain softening and meningitis.

(Mount Sinai Hospital No. 317794.) This fifteen-year-old boy gave no antecedent history of an upper respiratory infection. He stated that his symptoms began with left frontal headache three weeks prior to admission. For two weeks he had noted swelling about the left eye. His temperature had ranged about 103° . He appeared acutely ill. The left eye was completely closed by oedema of the lid and a large fluctuant swelling

extended from the eyebrow posterior to the coronal suture. The lesion was obviously a very advanced one. Operation was performed on the day of admission. One incision extended from the coronal suture to the eyebrow about four centimetres lateral to the mid-line, and a second incision was made over the posterior part of the parietal bone. There was a perforation in the bone posteriorly and some granulation tissue on the dura. Anteriorly diseased bone was removed and normal dura exposed. No epidural collection of pus was found. An orbital abscess was drained. A transfusion was given the next day, and the following day a radical external frontal sinus operation was per-



FIG 4.—(Case V.) Showing drained brain abscess outlined with iodized oil.

formed by Doctor Myerson. The posterior wall of the sinus was found necrotic and there was some exudate on the dura. On the following day a one diopter swelling of the disc and a bilateral Babinski reflex were noted. The neck was spastic. A spinal tap withdrew bloody fluid which was not believed to be traumatic from the puncture. The cell count on the following day when the fluid was yellow showed 1,200 cells, no organisms in spread or culture.

A week after the first operation an exploration of the left frontal lobe for a brain abscess, through a separate trephine opening, was negative.

Two days later the temperature rose to 107° and a small collection of pus was

evacuated from beneath the dura in the left parietal region. The patient died the same day.

Post-mortem examination disclosed a hæmorrhagic type of bronchopneumonia. In the left frontal lobe was a cavity communicating with the ventricle. Microscopical studies showed the presence of a meningitis and extensive encephalomalacia of the left frontal lobe.

CASE VII.—*Chronic osteomyelitis of skull secondary to frontal sinus infection. Persistent symptoms.*

(Mount Sinai Hospital No. 310760.) At the age of eleven years this boy had an acute infection of the right frontal sinus for which an external operation was done. Two and one-half years later (January, 1930) he entered Mount Sinai Hospital. A



FIG. 5.—(Case VII.) Productive osteitis involving entire frontal bone.

painless swelling had appeared over the left frontal region which opened and discharged. The boy was of the Froelich type. He showed a scar in the right eyebrow of a frontal sinus operation. There was a diffuse fluctuant swelling over the right frontal region extending from the hair line to the bridge of the nose, and a small non-fluctuant fusiform swelling over the left eyebrow. In the left frontal region a small crusted area covered a sinus which did not lead to bone. Operation exposed the bone to the right of mid-line and over the left frontal region through separate incisions. No disease of bone was seen and culture of the pus was sterile. The operative findings were surprising. The X-ray of the skull (Fig. 5) showed a diffuse thickening of the vertical plate of the frontal bone. The report of the X-ray read in part "this thickening seems to be limited entirely to this particular bone. Its appearance is not suggestive of any familiar pathological condition. It does not have the appearance of lues, of tuberculosis,

of osteomyelitis, or of malignancy." A week after the operation the patient was discharged.

Nine months later he was readmitted (Mount Sinai Hospital No. 320665). A small sinus had appeared in the scar in the right eyebrow. There was fluctuation at the previous operative site to the right of the mid-line. He gave a history of swelling of the left eyelid which had disappeared with warm applications. The old incision was reopened, an excavation of the outer table of the skull was found. Soft bone was removed with a curette, dura was exposed and found normal. A staphylococcus was recovered from the pus. The patient was seen at follow-up clinic. Four months later there remained a draining sinus. An X-ray showed a further increase in thickness of the vertical plate and an increased thickness of the horizontal plate as well. A questionable area of rarefaction is seen in the lesser wing of the sphenoid.

The type of bone reaction seen in this case is most unusual. It is productive rather than destructive. It is limited to the frontal bone and involves the horizontal as well as the vertical plate. The process is still active and may lead to some intracranial complication. Radical surgery is out of the question as it would entail the removal of the entire frontal and sphenoid bones.

There is a marked similarity between the cases in this group. With the exception of Case I there is a history of sinus infection followed by the appearance of a swelling of the forehead about an inch above the eyebrow. Six of the patients had an orbital abscess. In only one was there a positive blood culture. Cases I and IV had massive bone destruction, large pieces of the frontal bone coming away as sequestra. Three patients died, two are still suffering from their osteomyelitis, one having draining sinuses, and one still presents from time to time the characteristic painless swelling in the scalp. This latter patient shows by X-ray a very marked reaction of the entire frontal bones which differs from the moth-eaten appearance of the skull in the other cases. Successive röntgenograms show a steady progression of this reaction. The process has spread to involve the lesser wing of the sphenoid and in one view there appears to be an area of rarefaction in that bone. Two patients are well and healed. Complicating brain abscess was found three times in this group, two patients surviving this complication.

CASE VIII.—*Chronic osteomyelitis of skull from post-abortive sepsis.* Brain abscess drained fifteen years after onset of infection. Death two and one-half years later. Residual brain abscess, encephalomalacia of opposite hemisphere.

(Mount Sinai Hospital No. 267345, and Montefiore Hospital No. 16656.) Fifteen years before coming under observation in June, 1925, this forty-five-year-old woman had a sepsis following an abortion. Three years later a retro-orbital abscess and an abscess over the occiput had been incised and had healed. Four years before the present observation an abscess over the vertex of the skull opened spontaneously. This closed and opened numerous times in the four-year period. For two weeks she had had pain in the region of the abscess and persistent vomiting. At operation by Doctor Elsberg the sinus at the vertex was traced forward and to the right. A small epidural abscess and dura covered with granulations was found. Bone was removed until healthy dura was exposed. The operative wound healed. A year later the patient had a return of headache and became mentally dull. She had weakness of the left arm. Doctor Elsberg drained a right frontal lobe abscess. A hernia cerebri developed and the patient was left with a hemiplegia. Six months later she was admitted to Montefiore Hospital because of the hemiplegia. She died at that institution of subarachnoid hæmorrhage two years later. A post-mortem examination showed subarachnoid hæmorrhage with

encephalomalacia on the left side. In the tip of the right temporal lobe a very small chronic abscess remained.

For a period of fifteen years the osteomyelitis of the skull, which was metastatic, ran a very benign course. All the foci healed except for one which made its appearance eleven years after the original infection.

CASE IX.—*Chronic sepsis following trauma.* Osteomyelitis of skull. Brain abscess. Death.

(Montefiore Hospital No. 13501.) A boy of twenty years was admitted to Montefiore Hospital November 10, 1924. He had the appearance and general development of a child of thirteen years. A röntgenogram of his chest showed a persistent thymus. Four years prior to his admission his left leg had been amputated above the knee following an injury to his knee. This was followed by an abscess on the outer side of the left hip which opened spontaneously and left a draining sinus. A similar sinus followed an abscess in the region of the left wrist. X-ray examination of the hip was interpreted as possibly tuberculosis, that of the wrist chronic osteomyelitis of the ulna with a sequestrum. Three months later a "cyst" was incised over the right frontal area. A month later an abscess was incised on the upper third of the left arm. In November, 1925, a year after his entrance into the hospital, he had a generalized convulsion. This was repeated three times in the next seven weeks. About this time a fluctuant mass was noted over the vertex of the skull, but X-ray failed to disclose any bone destruction. The patient now complained of headache. He vomited and the convulsions were repeated. Examination of the fundi showed a papilloedema, and a weakness of the right face and hand were noted. January 23, 1926, the abscess over the vertex was incised. A perforation of the skull was found in which lay a small sequestrum. The dura was thickened and covered with granulations. Bone was removed over an area of three centimetres until normal dura was exposed. During the next ten days the weakness of the right arm and face increased. February 2 a left parietal lobe abscess was drained. The patient gradually grew weaker and died April 6. Post-mortem examination was not allowed. The pus from the scalp abscess and brain abscess both grew a *Staphylococcus albus*.

The skull infection in this instance was a metastasis in the course of a low-grade sepsis from a *Staphylococcus albus*. The early painless swelling of the scalp should have been recognized as an abscess and indicative of underlying bone disease. It was not until a year later that the second abscess appeared, and with it the signs of intracranial involvement.

These above-mentioned two cases developed their osteomyelitis as metastatic foci. In one the lesion in the skull followed a post-abortive sepsis. Twelve years after the first sign of cranial involvement the osteomyelitis was still evident, and a brain abscess was drained. She lived for two years after this, dying of a terminal subarachnoid hæmorrhage on the opposite side. The other case had a chronic sepsis for five years before there was any skull involvement. The process here went on for a year before a brain abscess was manifest.

CASE X.—*Primary osteomyelitis of the occipital bone.* Discharging sinus for eight months. Sequestrectomy. Healing.

(Mount Sinai Hospital No. 307379.) A man of fifty-four was taken ill four weeks prior to his admission. The onset was with chills and fever followed by a burning pain in the occipital region which radiated to the back of both ears, and then localized and persisted on the left side. He presented a swelling and painful œdema just back of the left mastoid over the occipital bone. His temperature was 100.4°. The otological service called in consultation could find no evidence pointing to an otitic origin. The

OSTEOMYELITIS OF SKULL

fever rose by steps and on February 22, 1929, the fourth day after admission, a subperiosteal abscess of the left occipital region was incised. No diseased bone was seen. The temperature dropped promptly. A week later an X-ray of the skull was reported negative and at the end of another week the patient was sent to the out-patient department for dressings. The sinus persisted and X-ray five months later showed evidence of bone destruction in the occipital region.

Ten weeks later he was readmitted to the hospital. A fluctuant area mesial to the draining sinus was found. When this was incised, a sequestrum the size and shape of a three-leafed clover was removed. The exposed dura was clean. Eight days later the patient was returned to the out-patient department for dressings. The wound healed promptly and when seen two years later had remained healed.

Except for the absence of extreme prostration, the onset of this illness was that of osteomyelitis elsewhere. The disease of the bone was close to the mid-line in the occipital region. The course was that of a well-localized focus. There was no tendency to spread and the condition cleared up promptly on the removal of a sequestrum which formed. This case may fairly be classified as a primary in the skull, in the sense that it did not originate in a contiguous sinus nor was it metastatic from a suppurative focus elsewhere.

CASE XI.—*Osteomyelitis beginning in frontal bone and spreading back to the occipital bone.* Conservative operative treatment. Recovery.

(Mount Sinai Hospital No. 249069.) In November, 1924, an eighteen-year-old girl was admitted because of multiple abscesses of the scalp. There was no known etiological factor determined when fifteen months previously she was treated for osteomyelitis of the frontal bone in another hospital. Ten months later in the same institution further bone removal in the frontal region was carried out and an epidural abscess drained. Draining sinuses persisted. New abscesses appeared and the patient developed headache for which she was admitted. She had a low-grade papilloedema but no further neurological signs. Several sinuses over the frontal region led to bone and several unopened abscesses were present back of the coronal suture line. Her hæmoglobin was 58 per cent. During a seven months' stay in the hospital further abscesses appeared posteriorly over the occipital bone. As these appeared they were incised and necrotic bone was removed. Culture grew *Staphylococcus aureus*. At one time her hæmoglobin reached as low as 32 per cent. She received two transfusions. Vaccine therapy was tried. In June, X-ray was reported as showing extensive destruction of frontal and occipital bones. Heliotherapy was begun in the hospital and continued after her discharge in the out-patient department, for she still had many draining sinuses over the frontal and occipital region. She finally dropped out of sight but reported four years later with all wounds healed.

With no antecedent history of trauma, and in the absence of nasal sinus infection, it is possible that this patient may have had a primary bone infection. The records of this case are not explicit, but to my best recollection she had at one time as many as six or eight draining sinuses. The use of heliotherapy was, I believe, an important factor in the fortunate outcome.

In these two instances of undetermined origin, Case X seems possibly a primary infection such as is seen in the long bones. There is a history of local pain, chills and fever, followed by the appearance of a local osteomyelitic process in the occipital bone. This remained localized, and, following the formation and removal of a sequestrum, healed promptly. The history of the other patient is not clear. It fails to give any antecedent illness or trauma, but also fails to state any facts which could be interpreted as an acute onset. Broca³ describes six cases of primary osteomyelitis of the skull, primary in

the sense that they were not extensions from contiguous infections, although several occurred in the course of infectious diseases. None of these cases originated in the frontal bone.

CASE XII.—X-ray treatment of epithelioma of scalp ten years previously. Trauma two years before admission. Osteomyelitis of skull, epi- and subdural abscesses. Sinus thrombosis. Death.

(Mount Sinai Hospital No. 283156.) A forty-eight-year-old man was admitted September 3, 1927, and died the following day. Ten years previously his scalp had been treated by X-ray for an epithelioma. Eight years later he received a severe blow at this site which resulted in ulcer formation. Biopsies of the ulcer failed to show any malignancy. A local osteomyelitis developed and four weeks prior to admission bone was removed disclosing a large epidural abscess. His temperature remained elevated and at times he was irrational. Blood cultures were repeatedly negative. His spinal fluid showed 125 cells and no organisms. A week prior to his admission there were no abnormal neurological findings. His temperature on admission was 103°. He was stuporous. There was a circular area of bare bone eight centimetres in diameter just posterior to the coronal suture, and in its centre a four-centimetre defect with dura exposed. There was an anæmia, and the deep reflexes were diminished. X-ray of the skull showed, in addition to the defect, the moth-eaten appearance of an osteomyelitis of the surrounding bone. At operation an extensive osteomyelitis was found and epidural granulations extending forward toward the left side. A subdural extracortical abscess containing about forty cubic centimetres of pus was drained. The patient died six hours after the operation in pulmonary œdema. The pus from the abscess was *Staphylococcus aureus*. A post-mortem examination showed a left epidural abscess, and left subdural extracortical abscess, thrombophlebitis of the cerebral veins and sinuses, a small brain abscess in the right temporo-parietal region, a right otitis media and a bilateral bronchopneumonia.

This case may be classified in the traumatic group. It is impossible to state what influence, if any, the epithelioma and the X-ray treatments had in addition to the trauma. The subdural abscess was large but well localized, as shown at post-mortem examination.

CASE XIII.—*Laceration of scalp*. Osteomyelitis of skull. Epidural abscess. Sepsis. Death.

(Mount Sinai Hospital No. 329558.) A twenty-eight-year-old man was admitted August 28, 1931. He stated that four weeks prior to admission he had fallen and sustained a laceration over the left frontal region. The wound seemed to heal kindly after suturing. Two weeks later, however, there was some pain at the site of the injury and the wound opened in part spontaneously and discharged pus. About this time there developed chills, fever and a throbbing headache. On admission the patient did not look sick in spite of a temperature of 104°. There was a swelling three centimetres above the left eyebrow and some œdema of that eyelid. From the centre of a six-centimetre scar at the summit of the swelling, pus was escaping through a small opening. The general physical examination was negative. On the day of admission the scar was opened widely to afford drainage. Bone denuded of periosteum was exposed but it appeared normal. There was an immediate drop in temperature following operation, but forty-eight hours later following a chill it rose to 105°. A blood culture was taken at this time. Two days later the patient was re-operated upon. It was thought that possibly an abscess deep to the temporal muscle had been overlooked. On extending the previous incision downward, a drop of pus was seen escaping from the bone just above the orbital ridge in its outer third. When an opening was made in the bone an epidural abscess was uncovered, overlying dura which was thickened and grey in appearance. Pus was seen in the bone. After the removal of bone over an area about six centimetres in diameter, normal bone was encountered toward the vertex, but though the removal was extended down to include part of the external angular process and greater wing of the sphenoid, the limit of disease

OSTEOMYELITIS OF SKULL

was not reached. The patient's temperature remained between 105° and 106° and he died two days later. The blood culture and the pus from the operative site contained a *Staphylococcus albus*. The post-mortem examination showed extensive osteomyelitis of the temporal, frontal, and sphenoid bones, a retrobulbar cellulitis, purulent exudate in the frontal and sphenoid sinuses, and a meningeal exudate localized over the frontal and temporal lobes at the site of the epidural collection of pus.

The widespread bone infection in this case was not secondary to a fracture. One must assume an infection of the diploic veins through a communicating branch, probably in the region of the supra-orbital notch, the source of the trouble being an infected hematoma at the site of the injury.

The grouping of the cases, as has been done in this paper, is purely an artificial one. The disease exhibits much the same characteristics in all the groups. McKenzie uses the term "spreading osteomyelitis of the skull" in writing of the cases following sinus infection, but it is just as applicable to any type. Fleming states that in children periosteal partitions may limit the process to one bone. In the infant, Case III, the disease was limited and though she lived only six months there was ample time for involvement of the contiguous bones. A characteristic of the spread of the disease is that the extension may show itself by an abscess often several inches distant from the last known focus. Thus if the first abscess makes its appearance over one frontal eminence, the second may appear over a corresponding point on the opposite side. These secondary abscesses often contain a small flake-like sequestrum, or show a small erosion of one or both tables of the skull without sequestra. Frequently the intervening bone to all appearances is normal, and subsequent events prove this to be so. This peculiarity is one argument in favor of the spread by means of thrombosis of the veins, at least in some instances. When there is mass destruction with the formation of sequestra, several centimetres in diameter, involvement of the entire diploe is probable.

When a scalp abscess is incised a little roughness of the outer table may be all that is found, or there may be a sequestrum, a flake of that table. At other times, especially when a perforation through both tables is present, the destruction of the inner table can be more widespread than the outer. It is in such instances that granulations cover the dura, or pus is found between the bone and dura. The pus here bears the same relation to the inner table that the abscess under the scalp bears to the outer, that is, a small collection of pus well localized to the operative site. This is not always the case, especially when there is extensive bone disease. A large epidural abscess may be encountered or a sinus track marked by granulations may lead from the site of perforation of the skull to a true epidural abscess several inches away. In some instances a perforation through the dura will disclose a subdural abscess. A brain abscess is more likely to occur than a large extracortical abscess. As McKenzie points out, the inflammatory reaction in the dura causes an agglutination of the dura and the subdural membranes. Brain abscess occurred as a complication in six of the thirteen cases in this series. Only Cases III and XII did not have an epidural collection of pus directly overlying the brain abscess. This suggests strongly that the brain

abscess in the other four cases resulted from direct extension. In Case III the brain abscess finally appeared at the site of the skull perforation although there was no epidural collection. In Case XII there was a large subdural collection of pus on one side and at post-mortem a small brain abscess in the opposite hemisphere.

Bacteriology.—There are available data on the bacteriology in ten cases. In seven *Staphylococcus aureus* was grown from the pus, in two the *Staphylococcus albus*. A streptococcus was the organism in one case; it was recovered both from the site of the bone disease and from the brain abscess.

The *symptomatology* of osteomyelitis of the skull is largely that of its complications. The primary cases present malaise, or even prostration, local pain and fever. The onset of the secondary cases is often overshadowed by the picture of the nasal sinus involvement. After that condition is cared for, and in the absence of other complications, high fever is not the rule even with relatively widespread extension. The abscess of the scalp marking the site of an extension makes its appearance insidiously. It lacks heat and may not be particularly tender. Prior to its appearance the patient often complains of generalized headache. This same picture was found in the metastatic abscesses that appeared during a chronic sepsis. For the very reason that extensions of the disease take place without general manifestations and without subjective symptoms, they must be watched for constantly. The same holds true for the intracranial complications. For a time headache and lassitude may be the only signs of a brain abscess. Careful and repeated neurological examinations and eye-ground studies must be made on such patients.

The usual X-ray picture is that of a moth-eaten bone. Areas of rarefaction may be separated by several centimetres of normal-looking bone. With extensive disease these areas are close together. Sequestra are difficult to visualize, but may at times be seen. A productive process is usually not observed, but in Case VII there was noted an increased density of the frontal bone involving the horizontal as well as vertical plates and extending into the lesser wing of the sphenoid. This osteosclerosis is comparable to that seen in chronic osteomyelitis of the long bones.

The course of the disease, in the absence of brain complications, is usually long drawn out, and in that respect does not differ from osteomyelitis elsewhere. But because of the proximity to the brain and the dangers of intracranial complications, osteomyelitis of the skull has its own peculiar problems. Case VIII first showed evidence of skull involvement by an abscess of the scalp three years after her post-abortive sepsis. It was another twelve years before the symptoms of brain abscess were manifest. Thrombosis of the sagittal sinus was met with in Case XII, a traumatic case. Fischer (quoted by Shilling) reports sinus thrombosis as a complication thirty times in traumatic osteomyelitis. Blair and Brown² give one instance in forty-six collected cases. With the involvement of the veins in the diploe it is surprising that this complication is not seen more frequently.

Treatment.—When the source of the osteomyelitis lies in the nasal sinuses these must be cared for adequately by a rhinologist. This procedure was carried out in the seven cases of nasal infection in this series. From the standpoint of treatment of the osteomyelitis of the skull, the question arises, as stated by Blair and Brown,² whether to follow the plan advocated by McKenzie⁹ or to adopt a more conservative method. McKenzie advises, in those cases arising from a nasal sinus infection, a wide removal of the frontal bone in an effort to go beyond the disease and prevent its spread. Blair and Brown make a plea for very conservative treatment. They collected thirty-seven cases with twenty-five deaths under radical measures, and nine cases with three deaths treated conservatively. The latter therapy consists in opening scalp abscesses as they arise and in the removal of sequestra as they may be found in these abscesses. Additional bone is removed when an approach is made to an underlying abscess. There seems to be some difference in the behavior and tendency to spread of primary osteomyelitis, and that associated with nasal sinus disease. The spread of the former is often limited. That infection from sinus disease may be just as limited is apparent in Cases III and V. The ultimate destruction of bone in these patients was limited to an area not larger than a ten-cent piece. Both of these patients developed frontal lobe abscesses beneath the site of the osteomyelitic process. The most widespread involvement occurred in Case XI, in which the etiology is not clear. There is no difference in spread directly traceable to the type of infecting organism. It may be that the answer is to be found in the virulence of the organism in question. Certainly in the two metastatic cases cited, the behavior of the infection was that of an attenuated organism. McKenzie makes a distinction between osteomyelitis which develops following a sinus operation, and that which is concomitant with the sinus infection. One would be inclined to believe this classification artificial (especially since the secondary type usually follows operation on the acute and not the chronically infected sinuses) were it not for the fact that McKenzie reported twenty cases of the post-operative type all ending fatally, while seven recoveries took place in the spontaneous group of twenty-one cases. Munro¹⁰ recently made a careful analysis of 231 cases. His figures show a higher percentage of deaths occurred under conservative treatment, while in the recovered cases the percentages were more nearly equal, being slightly in favor of the conservative treatment.

In so far as the radical treatment means the removal of obviously diseased bone, it is rational. But the removal of bone *en bloc* in an effort to go beyond the disease and prevent its spread does not seem warranted. Since the spread of the process is by diploic channels, by the time the first localization shows itself in the typical swelling of the scalp, the infection may well have reached a place three or four or more inches distant to show itself by a similar swelling days later. This does not mean that the intervening bone is destroyed. Neither does the onset of an osteomyelitic process mean that of necessity there will be any spread. Case V is a good illustration of this. I, therefore,

take a middle course, if it can be called this, removing such bone as is grossly and obviously diseased. On the one hand one cannot be sure of preventing a spread by more radical removal *en bloc*, nor can one prognosticate which case will need it; on the other hand to leave bone oozing pus from its edges to await sequestration is inviting intracranial complications.

There were seven deaths in this series of thirteen cases. One death occurred two years after all symptoms referable to the osteomyelitis had subsided, and is included only for the sake of completeness. One patient died within twenty-four hours after coming under observation with a subdural abscess, a brain abscess and a sinus thrombosis. Three others died of brain abscesses. One patient died with an acute spreading osteomyelitis and a meningitis. The seventh death was not fully explained; it may have been due to toxæmia or an unproven basilar meningitis. Of the living patients two had brain abscesses. One of these still has an unhealed sinus leading to the skull. Three are perfectly well. The boy with the sclerosing type of osteomyelitis is an unfinished case.

Whether one studies a small series, as in this paper, or reviews a large number of cases, the seriousness of the disease is manifest. It threatens both from the standpoint of the bone involvement and from the extreme probability of intracranial complications. The insidiousness of its spread and of the onset of its complications make most careful observation imperative. One should be prepared for prompt action in a case that has gone along satisfactorily for months or years.

BIBLIOGRAPHY

- ¹ Bergmann, A.: Ueber Acute Osteomyelitis Specieell der Flatten Knochen. St. Petersburger Med. Woch., vol. i, pp. 381, 389, 1884.
- ² Blair, V. P., and Brown, J. B.: Septic Osteomyelitis of the Bones of the Skull and Face. ANNALS OF SURGERY, vol. lxxxv, p. 1, 1927.
- ³ Broca, A.: Chirurgie Infantile, p. 330, 1914.
- ⁴ Bryan, J. H.: Report of a Case of Extradural and Subdural Abscess Following Suppurating Frontal Sinusitis and Osteomyelitis of the Frontal Bone. Am. Jour. Med. Sci., vol. clx, p. 687, 1920.
- ⁵ Bulson, A. E., Jr.: Osteomyelitis of the Frontal Bone as a Complication of Frontal Sinusitis. Trans. Am. Acad. Ophthal. and Otolaryng., p. 103, 1925.
- ⁶ Fleming, H.: Osteomyelitis of the Skull. Calif. and West. Med., vol. xxiii, p. 985, 1925.
- ⁷ Fischer, H.: Die Osteomyelitis Traumatica Purulenta Cranii. Deut. Zeit. Chir., vol. lvi, pp. 100, 449, 1900.
- ⁸ Lemere, H. B.: Progressive Osteomyelitis of the Frontal Bone. Jour. Am. Med. Assn., vol. lxxx, p. 596, 1923.
- ⁹ McKenzie, Dan.: Diffuse Osteomyelitis from Nasal Sinus Suppuration. Jour. Laryng., Rhinol. and Otol., vol. xxviii, p. 6; vol. lxxix, p. 129, 1913; Further Observations on Spreading Osteomyelitis of the Skull, Jour. Laryng. and Otol., vol. xlii, p. 293, 1927.
- ¹⁰ Munro, D.: Non-traumatic Osteomyelitis of the Flat Bones of the Skull. South. Surg. Trans., vol. xliii, p. 403, 1930.
- ¹¹ Schilling, R.: Ueber die Osteomyelitis der Flatten Schadelknochen im Anschlusse an Entzündungen der Stirnhöhle und des Mittelohres. Zeit. f. Ohrenheilk., vol. xlviii, p. 52 (Supplement), 1904.

THE USE OF CONTINUOUS INTRAVENOUS INFUSIONS IN ACUTE ABDOMINAL CRISES*

By ISIDOR S. RAVDIN, M.D., AND CHARLES G. JOHNSTON, M.D.
OF PHILADELPHIA, PA.

FROM THE DEPARTMENT OF SURGERY (DIVISION E) OF THE HOSPITAL OF THE UNIVERSITY OF PENNSYLVANIA

A REVIEW of the literature of some years ago on various types of acute abdominal crises will show that the clinician had focused his attention primarily on the method of operation, once the diagnosis of a surgical condition had been established. Within the past few years more attention has been directed at two other equally important measures, the pre-operative and the post-operative care, the adequate conduct of which bear a close relationship to the mortality of the lesion under consideration.

That water is a necessary component of all living cells is accepted by all biologists. In man it accounts normally for 70 per cent. of the body weight. The maintenance of good health demands that the cells be bathed in a fluid medium which normally remains remarkably constant in its organic and inorganic constituents. Any variation in the normal chemical constitution of the fluids bathing the cells vitally affects cell activity. Furthermore, cell activity is affected when the total water content is varied greatly in either direction from the normal.

As a result of an appreciation of these facts the clinician has focused his attention more and more on the fluid and salt requirements of the surgical patient. In few conditions is an appreciation of this subject more necessary than in the acute abdominal crises of an obstructive or suppurative character.

The disordered intestinal peristalsis prohibits the administration of fluids by mouth. Not only is ingested fluid vomited but in addition to this the fluids secreted into the gastro-intestinal tract may also be lost in large amounts. Thus, the many methods suggested for administering fluids through tubes placed in the stomach, gall-bladder or common duct are of no use in peritonitis, dynamic or adynamic ileus.

The withholding of an adequate fluid intake by mouth for a short period is not in itself dangerous. Simple restriction of fluid intake is usually partially compensated for by a restricted loss. Such a state of mild dehydration can, if no contra-indications exist, be corrected by the simple ingestion of water. The severely ill, dehydrated patient, however, presents another problem.

The loss of fluid from intestinal fistulæ or by vomiting is associated not only with water loss but also with a loss of various salts. The restriction of food intake during the period of acute illness when oral feeding is impossible, or contra-indicated, results in a further drain on the tissue stores of the

* Read before the Philadelphia Academy of Surgery, October 3, 1932.

body. It, therefore, becomes a problem of major importance for the successful outcome of the case to consider not only the simple water balance, but also the metabolic and the chemical balance of the patient. Indeed, it is impossible in patients of the type under discussion to separate these three factors. In the majority of instances of vomiting, the major ions lost are sodium, chloride and bicarbonate. The persistent loss of these ions ends in a disturbance of the acid-base balance so that the environment of the cells is no longer a normal one. Whether the final condition is one of alkalosis or acidosis depends on the degree to which acid or base ions are lost. The restricted intake of carbohydrate at a time when body tissues are being rapidly broken down may result in an associated ketosis.

The storage of tissues in the body necessitates fluid. The breakdown of tissues results in a liberation of water and the loss of water from tissues undoubtedly results in tissue breakdown. The dehydration so frequently observed in these cases causes an increased viscosity of the blood, added work on the heart with a tendency to a reduction of the blood-pressure; a decrease in the oxygenation of tissues; a disturbance of the heat-regulating mechanism which in turn aggravates the dehydration by increasing the loss of water by evaporation and sweating. Associated with these disturbances is a restriction of kidney output and a piling up of certain metabolites in the blood which in themselves detrimentally affect cell activity.

Under normal conditions the saliva, gastric juice, bile, pancreatic secretion and succus entericus account for as much as 7,000 to 8,000 cubic centimetres of fluid entering the gastro-intestinal tract per day. When it is considered that these fluids contain salts and that in part the salts and nearly all of the fluids are reabsorbed together with those ingested before the faeces are expelled, it is easy to realize what a highly important part the intestine plays exclusive of the part it takes in the absorption of foods.

When, therefore, it is impossible to take fluids by mouth and when added to this there occurs an actual loss of fluid and salt by vomiting, the successful outcome of an operation may depend upon a partial restoration of the fluid and salt balance previous to operation and its maintenance thereafter. In the simple surgical case the loss of fluid may be considerable but in an illness of short duration the water stores in the skin, subcutaneous tissue and muscle may not be exhausted. It is in the bad-risk case, whose easily available water stores have been depleted, that an adequate consideration of the biological requirements of the individual is essential.

In a discussion of fluid balance, where the disease is of short duration, it has been a practice to measure the intake of fluid, by any route, and to compare this with the loss through the urine and any other directly and easily measured route, as for example the vomitus. This comparison, however, is not accurate since it fails to take into account the insensible loss of fluid and that lost by sweating. In the very sick patient and especially in the suppurative abdominal cases, in which vomiting or regurgitation is a prominent and persistent feature, one must also take into consideration the insen-

sible loss of water and solids as well as that lost through other channels. These patients who only too frequently have dilated peripheral capillaries, whose skin is more often than not leaking considerably, may, as Wiley and Newburgh¹ have pointed out, lose more fluid through the skin and lungs than through the kidneys. Recently, Collier and Maddock² have reëmphasized this factor in a study of surgical patients. To depend solely on the sensible loss of fluid may result in a fluid intake far too small for the basic requirements of the patient. The insensible loss of water through the skin and lungs may, as Wiley and Newburgh¹ have shown, vary from 1,000 to over 3,000 cubic centimetres per day and this does not include that which is lost by sweating.

Fortunately, we have at our disposal simple methods for determining the salt and fluid requirements of the patient. The determination of base is unnecessary, while that of chloride and urea nitrogen and occasionally of bicarbonate is important. These substances, plus a careful study of the urine for ketone bodies, will in nearly every instance give the chemical data which the surgeon requires for treatment.

The existence of dehydration can often be determined by the texture of the skin and mucous membranes. Daily hæmoglobin estimations are also of considerable value and if to these is added the determination of the plasma protein we have as a rule all the information necessary. Recently, Dolch and Poechmuller³ have described a simple method for determining the water content of blood and serum and it may if it continues to prove satisfactory be added to the above studies. If simple intake and output studies are depended upon, an adequate amount should be added to the intake to compensate for the insensible loss and the loss through sweating.

In patients with acute abdominal crises only three routes for the administration of fluid are available—the rectal or colonic, in which we include the administration of fluid through a cecostomy, the subcutaneous, and the intravenous. The method adopted must consider the fluid, the salt and the metabolic requirements of the patient.

It is rarely possible in acute abdominal crises to administer sufficient fluid by proctoclysis over a prolonged period to maintain basic requirements. Furthermore, the introduction of large amounts of fluid may not only be poorly tolerated but may set up peristalsis which other treatment is attempting to overcome. Where the indications exist for the rapid introduction of fluid as in a short pre-operative period the time limitations preclude its use. And lastly, where it is also advantageous to give glucose along with water and sodium chloride the total amount of glucose which can be absorbed from the colon in any concentration is too small, as Ebeling⁴ and others have shown, to be of any material value.

The method of subcutaneous injection has many advocates. The fluid may be given intermittently or continuously. Large amounts of normal saline can be introduced by either method. The use of glucose even in low concentrations, by this method, is not without danger to the tissues. The method even when used as advocated by Bartlett is not painless. Febrile

reactions of moderate or severe grade frequently follow its prolonged use as the tissues react to the continued injury. In the presence of a failing circulation fluid is not absorbed in appreciable amounts.

About eleven years ago, Dr. George P. Muller and one of us began the sporadic use of continuous intravenous infusions in certain of our bad-risk abdominal cases. We were favorably impressed with its possibilities but our set-up was not very good, and, what was more important, we were discouraged by the high percentage of post-infusion reactions. Nevertheless, we continued to use the method from time to time.

In the meantime, other surgeons had written on the usefulness of the method. Matas,⁵ Penfield and Teplitzky,⁶ Hendon,⁷ Horsley⁸ and others have published data which supported the contention that in certain instances the method is superior to any other. In 1929, we began to reinvestigate the subject and adopted a method which is a modification of that used in the Presbyterian Hospital in New York. Intravenous reactions still discouraged us and it was not until Rademaker,⁹ following the investigations of Florence Seibert,¹⁰ conducted a series of studies and revised our technic for preparing the solutions that the method has shown its true worth.

The assurance that the fluid enters the blood-stream at a predetermined rate, which will not tax an embarrassed circulation, increasing evidence that the absorption of material amounts of glucose by the rectum and colon is not possible, and the ease with which posture can be changed if the proper technic is utilized, have all contributed to make this method increasingly popular.

In the vomiting associated with peritonitis and adynamic ileus the blood composition is practically the same as that seen in high intestinal obstruction. These patients frequently have an actual alkalosis from the prolonged loss of chloride in excess of base. The frequent diagnosis of acidosis in these cases merely because of the presence of acetone and diacetic acid in the urine is incorrect. The intravenous administration of sodium bicarbonate to such cases is reprehensible. It is just as possible to have alkalosis with ketosis as acidosis with ketosis and it should be remembered that the number of cases of true acidosis which the surgeon sees is indeed few.

We believe that when fluids are given intravenously the constant slow drip is more satisfactory than the rapid introduction of large amounts which result in the activity of certain types of cells which ordinarily are not called upon to play a part in the process of adjusting to ingested fluid. Swale Vincent¹¹ has demonstrated that the transitory fall in blood-pressure which may accompany intravenous injections of saline is more rapid the greater the rapidity of the injection. When the infusion is given slowly the circulation is not further suddenly taxed by a large amount of fluid rapidly injected.

There are as yet certain theoretical disadvantages of the method even when carried out by the best technic. We as yet know very little of the changes which occur in the individual tissues secondary to the changes induced in the blood. These would appear to vary with differences in renal

or hepatic function, the presence or absence of fever, the recent history of the organism with respect to water and salt balance, the influence of drugs and perhaps other undetermined factors. Data concerning these changes are still scanty and generalizations are premature. Nevertheless, clinical experience has shown that in certain pathological conditions its value has been established. Each extension of this field of therapy should, however, be considered as an experiment and should be conducted with due caution.

The important thing to remember in dehydration in the cases associated with continued vomiting, whether there exist alkalosis or acidosis, with or without ketosis, is that it is much more important first to correct the dehydration as Gamble and his coworkers¹² have shown than it is to attempt to correct blood reaction. The keystone of the situation is a properly functioning kidney. Given this, normal sodium chloride will correct the dehydration and at the same time correct blood reaction. Ketosis in the acute abdominal crises usually can be corrected by the simultaneous administration of glucose. In alkalosis, base will be eliminated and chloride retained and in acidosis base will be retained and chloride eliminated following the administration of sodium chloride. The use of sodium bicarbonate is only rarely indicated. Unless the depletion of bicarbonate is extreme, a condition which as a rule is rare in surgical practice, sodium chloride will provide the base or acid ions necessary. Gamble,¹² whose studies have done much to enlighten this subject, has used sodium bicarbonate in certain cases of nephritis in children but even here its use was of little value.

If there exists an impairment of renal function the introduction of hypertonic glucose solution should precede the infusion of sodium chloride, so as to stimulate renal activity.

With this method, the control of dehydration, as met in cases of the type under discussion, is relatively simple as far as the solutions to be used are concerned. There may be advantages in the use of Ringer's solution as practiced by Horsley,⁸ but we have found that sodium chloride is quite satisfactory. The glucose as a rule is used in a 5 per cent. concentration in the saline. If additional glucose is desired the concentration can be increased.

The amount of fluid administered varies with the individual case but in the majority of instances it has, in our cases, approximated from 3,000 to 3,500 cubic centimetres in twenty-four hours. We have, however, in patients who were vomiting very large amounts and whose loss through the skin was considerable, had to give as much as 7,000 cubic centimetres in a twenty-four-hour period. With a 3,000-cubic-centimetre intake, 150 grams of glucose are given the individual in a day. This, of course, provides a very low caloric value to a patient whose metabolic rate is speeded up by infection, but it spares the tissues to a really amazing degree.

In only the rarest of instances is a cannula placed in a vein. Generally a No. 22 Luer needle which is perfectly clean is used. The flask containing the solution is placed on a high stand. Into the flask is placed a piece of rubber tubing which is fastened to a bent glass tube. This is connected

to a piece of tubing which in turn is connected to a glass tube which passes through a rubber stopper fitting into the barrel of a twenty-cubic-centimetre Luer syringe. The tip of the syringe has rubber tubing attached to it, into the other end of which is fitted a Luer adapter. The syphonage is started by suction and the rate regulated by a Hoffman clamp. A Luer syringe is used to make sure that the needle is in the vein and then the adapter is connected to the needle and the system functions. Small adhesive straps fix the needle and a portion of the tubing to the forearm or leg, depending on the vein that is used. The extremity is then enclosed in a pillow for immobilization. The solutions we have used are not heated above room temperature. It is true that the temperature of the solution is slightly elevated as it slowly flows through the rubber tubing fixed to the arm and enclosed in the pillow. This is accomplished by the patient's own heat. The actual heat expended in heating the solution once it enters the vessel is when calculated per hour of time infinitesimal when compared to the heat lost by surface irradiation during the same time period. Furthermore, since many of these patients have a marked elevation of the temperature the introduced fluid assists in a minor degree in reducing the body temperature.

The system will frequently function for twenty-four hours or more without changing the needle.* Thrombosis of the vein occasionally occurs. We have never had infection of the soft parts result after the use of the method, although we have continued the method for as long as twenty-one days using at alternate periods the veins in either antecubital fossa. The position of the patient can be changed at will. The method causes no pain unless the needle slips out of the vein. We are convinced that it offers advantages which cannot be obtained by any other means. With this method the inorganic constituents of the blood, especially chlorides and base, can be maintained at normal or nearly normal levels over a long period. The occasional use of hypertonic glucose solution to stimulate kidney activity will tend to reduce the increase in urea nitrogen which is so frequently elevated in these patients. If the kidneys have been previously damaged one must be cautious in the use of large amounts of saline since salt retention may result. In such cases glucose in distilled water should be used as the major fluid and the saline given in amounts which can be readily handled.

The plan which has been outlined cannot be used as a routine procedure. Each patient must be studied during the progress of the disease and the fluid, salt and caloric requirements must be adjusted to meet the exigencies of the case.

CASE REPORTS—CASE I.—*Diagnosis*.—Acute intestinal obstruction, A. S., female, aged thirty-nine years. Sixty-six hours before admission she was seized with sudden severe pain in the right lower abdomen. The site of this pain was an incisional scar the result of a laparotomy performed nine years previously at which time she had a salpingo-oöphorectomy, appendectomy and cholecystectomy. Soon after the onset of the pain she began to vomit and this continued until the time of admission, at which time the vomiting was fecal in type. The patient was semi-comatose, her skin was dry and the tongue was parched and coated.

INTRAVENOUS INFUSIONS IN ABDOMINAL CRISES

Systolic blood-pressure, 100 mm. of mercury; diastolic, 88 mm.; pulse, 140; temperature, 99° F.; respiration, 38; hæmoglobin, 118 per cent.; white blood-cells, 6,700. Abdomen markedly distended. Peristalsis loud and tinkling.

A Jutte tube was passed into the stomach and 1,120 cubic centimetres of dark brown, fecal-smelling material were removed. A continuous intravenous drip was established and the patient was given 1,000 cubic centimetres of 5 per cent. glucose in normal saline. She was taken to the operating room with the Jutte tube in place and the intravenous drip continuing to flow. She was so drowsy that she would not respond to questions. We decided that spinal anæsthesia would permit of a more rapid operation with less trauma. She was given fifty milligrams of ephedrine sulphate about twenty minutes before introducing the anæsthetic and fifty milligrams more just previous to the introduction intrathecally of 150 milligrams of neocaine. Within twenty minutes it was impossible to record either the systolic or diastolic pressure. Adrenalin injected subcutaneously did not prevent the fall and she was thereupon given 310 cubic centimetres of 10 per cent. glucose and three minimums of adrenalin intravenously when the blood-pressure slowly began to return.

Exploration of the abdominal cavity disclosed a dark reddish-blue loop of ileum which was caught under a broad adhesion extending from the abdominal wall to the uterus. The adhesion was resected and the loop freed, whereupon the color of the intestine improved rapidly.

An enterostomy was performed just proximal to the site of the obstruction and 300 cubic centimetres of fluid were immediately drained into a receptacle. The intravenous drip was continued during the operation and at the time of closure of the wound the systolic pressure was 160 and the diastolic pressure ninety millimetres of mercury. Her pulse was 120 at this time.

During the first eleven hours she received 3,500 cubic centimetres of 5 per cent. glucose in normal saline. It was only then that the plasma chlorides were estimated. These were found to be 5.28 grams per liter. The loss of fluid from the Jutte tube, enterostomy and through the kidneys amounted to 3,350 cubic centimetres. At this time the patient was conscious and could answer questions rationally.

In the succeeding twenty-four hours she received 4,450 cubic centimetres of 5 per cent. glucose in normal saline by intravenous drip and had an output of 2,065 cubic centimetres exclusive of the insensible loss and the loss through sweating.

She began to perspire freely so that in the following twenty-four hours she was given a total of 5,690 cubic centimetres, 3,800 cubic centimetres being 5 per cent. glucose in normal saline and 1,890 cubic centimetres normal saline without glucose. Her visible output during this period was 3,335 cubic centimetres. The hæmoglobin under this therapy dropped to 75 per cent. and the plasma chlorides rose to 6.15 grams per liter. Her condition improved rapidly.

On the third post-operative day the urine output increased to 1,920 cubic centimetres and the Jutte tube drainage was only 100 cubic centimetres. She drained 850 cubic centimetres from the enterostomy tube. Forty-five hundred cubic centimetres of 5 per cent. glucose in normal saline were given during this period by the continuous intravenous drip. On the fourth day she had a normal stool and fluids were begun by mouth, the intravenous drip being discontinued. She subsequently made an uneventful recovery.

CASE II.—*Diagnosis*.—Acute appendicitis with peritonitis. A. G., male, aged fifteen years. Seventy hours previous to admission he complained of pain around the umbilicus for which he was given a cathartic. His pain subsided during the day but then became more acute and he began to vomit. He continued to vomit and became feverish, but was given another cathartic. His symptoms increased and on the third day after onset he was admitted to the University Hospital.

The facies were anxious. The skin and mucous membranes were extremely dry. Respiration was rapid and shallow and there were no abdominal respiratory move-

ments. The abdomen was distended, rigid and tender throughout. Peristalsis was barely perceptible.

Temperature, 105° F.; pulse, 134; respiration, 34. White blood-cells, 14,000; hæmoglobin, 97 per cent. Plasma chlorides were 4.86 grams per liter.

Operation was under nitrous oxide and oxygen anæsthesia reinforced with ether. Through a McBurney incision a perforated, gangrenous appendix and 800 cubic centimetres of pus were removed from the abdominal cavity. Drainage was established and the wound closed. A pure culture of *B. coli* was obtained. He was given 750 cubic centimetres of normal saline to which forty grams of glucose were added during the progress of the operation.

In the twenty-four hours following operation he was given 1,350 cubic centimetres of normal saline and seventy grams of glucose by intravenous drip. On this day he showed ketone bodies in the urine. During this period we were troubled with frequent post-infusion chills so that an additional 600 cubic centimetres of normal saline were given by hypodermoclysis. The plasma chlorides rose to 5.50 grams per liter. The sensible output was 1,000 cubic centimetres. On the following day he was given 1,500 cubic centimetres of normal saline and 5 per cent. glucose. The intravenous drip was continued for twenty-four more hours at which time he was markedly improved.

On the seventh post-operative day he began to vomit and on the tenth post-operative day a jejunostomy was performed for obstruction. The plasma chlorides dropped to 4.74 grams per liter. He was given 1,500 cubic centimetres of normal saline and 1,500 cubic centimetres of 5 per cent. glucose in normal saline intravenously. To this was added 2,000 cubic centimetres by mouth which could be syphoned through the Jutte tube. The total sensible output was 4,800 cubic centimetres.

On the second day after the jejunostomy he was given 3,300 cubic centimetres of 5 per cent. glucose in normal saline, 750 cubic centimetres of normal saline by proctoclysis and 750 cubic centimetres of water by mouth. The total sensible output was 3,300 cubic centimetres. The plasma chlorides rose to 6.30 grams per liter on the third post-operative day.

On the nineteenth day after the appendectomy he developed a second obstruction with persistent vomiting, necessitating an ileostomy. At this time the intravenous drip was reestablished. He was given 3,000 cubic centimetres of 5 per cent. glucose in normal saline during the first twenty-four hours. The plasma chlorides were 5.60 grams per liter on the day after the second enterostomy. He was given 2,500 cubic centimetres of 5 per cent. glucose in normal saline on both the second and third days after operation. The plasma chlorides at this time were 6.08 grams per liter. During this period he, on three occasions, had ketone bodies in the urine for which additional glucose was intermittently administered. His condition rapidly improved and he was discharged fifty days after the initial operation.

BIBLIOGRAPHY

- ¹ Wiley, F. H., and Newburgh, L. H.: Jour. of Clin. Investigation, vol. x, p. 723, 1931.
- ² Collier, F. A., and Maddock, W. G.: Jour. of Am. Med. Assn., vol. xcix, p. 875, 1932.
- ³ Dolch, M., and Poehmuller, E.: Hoppe-Seyler's Ztschr., vol. cxcv, p. 28, 1931.
- ⁴ Ebeling, W. W.: Arch. of Surg., vol. xxvi, p. 134, 1933.
- ⁵ Matas, R.: ANNALS OF SURGERY, vol. lxxix, p. 643, 1924.
- ⁶ Penfield, W. S., and Teplitzky, D.: Arch. of Surg., vol. vii, p. 111, 1923.
- ⁷ Hendon, G. A. M.: Med. Arts and Indianapolis Med. Jour., vol. xxxiv, p. 491, 1931.
- ⁸ Horsley, J. S., and Horsley, G. W.: Arch. of Surg., vol. xxii, p. 86, 1931.
- ⁹ Rademaker, L.: ANNALS OF SURGERY, vol. xcii, p. 195, 1930.
- ¹⁰ Seibert, F.: Amer. Jour. Physiol., vol. lxxvii, p. 90, 1923.
- ¹¹ Vincent, S.: Jour. Pharm. and Exper. Therap., vol. xxxvi, p. 107, 1929.
- ¹² Drake, T. G. H., Marsh, P., and Gamble, J. L.: Amer. Jour. Dis. of Children, vol. xl, p. 705, 1930.

TROPACOCAINE HYDROCHLORIDE IN SPINAL ANÆSTHESIA

OBSERVATIONS BASED ON ONE THOUSAND OPERATIONS

BY JOSEPH A. LAZARUS, M.D., CHAS. J. PICK, M.D., AND
ARTHUR A. ROSENTHAL, M.D.

OF NEW YORK, N. Y.

THIS contribution is based on the use of tropacocaine hydrochloride in 1,000 cases of spinal anæsthesia. It is submitted with the view of placing on record our experiences with this product, to point out its advantages in urological and general surgery and to present a technic which in our hands has given most satisfactory results.

A satisfactory preparation for the induction of spinal anæsthesia must have a low toxicity, be soluble in small quantities of water or spinal fluid, and not decompose when sterilized. Tropacocaine hydrochloride was found by us to fulfill all of these requirements.

The committee on therapeutics of the British Medical Association has recently conducted experimental investigations of the various drugs used for spinal anæsthesia, and found tropacocaine hydrochloride to be satisfactory and safe.

The term "spinal anæsthesia" is really a misnomer, since no actual anæsthesia of the spinal cord takes place. What does occur is an extensive regional nerve block. Although we may use the words interchangeably in this paper, the process is one of spinal analgesia.

History.—Tropacocaine (benzoyl pseudotropeine) was first isolated by Giesel in 1891 from Javanese coca leaves. Liebermann was later able to successfully synthesize tropacocaine, while Willstätter produced it from tropine.

The physiological effects of tropacocaine hydrochloride were studied by A. P. Chadbourne,¹ in 1892, who found it to resemble cocaine in its physiological properties. Experimentation by Chadbourne showed it to be a powerful local anæsthetic, similar in action to cocaine, but differing from it in the following respects:

(1) Tropacocaine is much less toxic than cocaine. (2) The depressant action on the heart is less. (3) Anæsthesia is more complete and lasting. (4) Cocaine produces ischæmia while tropacocaine gives rise to an evanescent hyperæmia. (5) Tropacocaine solutions are slightly antiseptic and retain their strength for a period of at least six months. Cocaine solutions are less stable, retaining their strength for a much shorter period. (6) The relation between toxicity and dosage is more constant with tropacocaine than with cocaine. (7) Recovery from the effects of tropacocaine is much more rapid.

The first mention of the use of tropacocaine in spinal anæsthesia was made by K. Schwartz,² in 1901, who strongly advocated its use in place of

cocaine and eucaine. Acting upon his suggestion, Meyer,³ Neugebauer,⁴ and Kopfstein,⁵ used tropacocaine and found decided advantages over other preparations used for spinal anæsthesia.

Physiological and Pharmacological Properties.—Tropacocaine Hydrochloride Merck is an alkaloidal salt having the formula $C_8H_{14}NO.C_6H_5CO.HCl$, and occurs as colorless crystals readily soluble in water. It destroys the vasoconstrictor action of epinephrine. Its toxicity is stated by Sollmann⁶ to be one-half that of cocaine. The preparation used by us is in the form of a 10 per cent. solution of tropacocaine hydrochloride Merck in an 0.6 per cent. sodium chloride solution. Commercially it is supplied in 5 per cent. and 10 per cent. solution ampuls of one cubic centimetre each, sterile, and hermetically sealed, ready for administration. The solution is colorless, and is easily drawn up into the syringe through a needle of any gauge. In this respect it is decidedly more advantageous than other spinal anæsthetics, because of the facility of administration without resorting to the necessity of dissolving any crystals in an ampul with spinal fluid.

Tropacocaine, like other spinal anæsthetics, produces a physiological block of the nerve roots when the solution comes in contact with them. It primarily produces a block of the posterior or sensory roots and to a lesser degree the anterior ones. The extent of involvement depends chiefly upon its diffusion, which in turn is dependent on the dosage, the level of injection, the force with which it is injected and the individual susceptibility of the patient. Tropacocaine is excreted chiefly through the kidneys.

Duration of Tropacocaine Anæsthesia.—The duration of anæsthesia depends upon the strength of the solution and the dosage employed. In the majority of our cases (intra-abdominal operations) one and one-quarter cubic centimetres of a 10 per cent. solution were used, and gave an average duration of the anæsthesia of from one hour to one and one-quarter hours. For more extensive operations one and one-half to two cubic centimetres were used, which prolonged the anæsthesia to two hours. For extra-abdominal operations, the larger doses are unnecessary, as anæsthesia produced with one cubic centimetre lasts fully an hour.

Selection of Patients for Tropacocaine Spinal Anæsthesia.—We were guided in the selection of our patients for spinal anæsthesia by the type of operation to be performed, the age and the physical condition of the patient. The same careful evaluation of the risk involved must be made as with general anæsthesia. In most operations below the diaphragm, tropacocaine hydrochloride intraspinally was the anæsthesia of choice.

Among the types of operative procedures conducted in this series of 1,000 cases were the following: prostatectomy, orchectomy, plastic operation on the penis, varicocele, plastic repair of vagina, ectopic gestation, salpingectomy, oöphorectomy, hysterectomy, plastic repair of urethra, appendectomy, intestinal resection, herniotomy, suprapubic cystotomy, nephrectomy, pyelotomy, nephrotomy, ureterotomy, cholecystectomy, cholecystoduodenostomy, gastro-

enterostomy, gastrectomy, excision of hæmorrhoids, operations for osteomyelitis and reduction of fractures.

Indications for the Use of Tropacocaine.—We have found tropacocaine particularly useful in the following classes of operations and complications:

(1) *Intestinal Obstruction.*—Its advantages here are due to its tendency to produce complete relaxation of the abdominal muscles and the viscera.

(2) *Emergency Surgery.*—We have found tropacocaine particularly useful in emergency operations, where time did not permit of a complete evaluation of the patient's physical condition prior to operation.

(3) *Upper Respiratory Infections.*—Tropacocaine proved of particular value to us in operations which were complicated by pulmonary tuberculosis, emphysemæ, pneumonic processes, and other infections of the respiratory tract. The reduced incidence of post-operative pneumonitis following intra-spinal anæsthesia is well known.

(4) *Metabolic Complications.*—We have found tropacocaine to be of value in operations complicated by metabolic disorders such as diseases of the liver, pancreas, kidneys and glands of internal secretion, where ether anæsthesia has a tendency to produce marked degenerative cellular changes.

(5) *Hypertension.*—In cases associated with hypertension, tropacocaine hydrochloride is particularly useful. It is our custom to give three-quarters of a grain of ephedrine sulphate one hour preceding its administration, and a second dose of the same quantity immediately preceding the operation, as a means of reducing the tendency to any sudden and marked drop in the blood-pressure. Failure to follow this routine resulted in a drop in pressure in one of our cases, from 230 systolic to a point where it was not readable. In this particular instance the pulse became imperceptible, skin cold and clammy, and a true vasomotor collapse ensued, which quickly responded to the administration of three-quarters of a grain of ephedrine. Since this experience we have never deviated from the routine of pre-operative administration of ephedrine.

(6) *Use with Cautery.*—There is no contra-indication to the use of this type of anæsthesia when employing the actual cautery or any electrical apparatus producing a spark.

Contra-indications to the Use of Tropacocaine.—(1) *Neuroses.*—We have found in cases of highly nervous patients that the anæsthesia frequently had to be supplemented with inhalation narcosis because of the failure of the patient to coöperate. Morphine administered before the induction of anæsthesia has a tendency to allay apprehension in some of these cases.

(2) *Cerebrospinal Lesions.*—Although the consensus of opinion among investigators has been that spinal anæsthesia is contra-indicated in diseases of the cerebrospinal system we have found the use of tropacocaine in patients both with recent and long-standing hemiplegias and in a number of cases with cerebrospinal lues not accompanied with any untoward results.

(3) *Hypotension.*—Spinal anæsthesia has been considered as contra-indicated in hypotension, but we have found that, since adopting our routine

of the preliminary administration of ephedrine, patients with a systolic pressure as low as 100 or even 90 suffered no ill effects following the use of tropacocaine hydrochloride.

(4) *Diseases of the Spinal Column*.—Deformities of the spine, suppurative changes and osteo-arthritis are, as a rule, contra-indications to the use of spinal anæsthesia, because of the technical difficulties which may be encountered and the added danger of infection.

(5) *Diseases of the Skin over the Spine* offer a definite contra-indication to this type of anæsthesia.

(6) *Shock*.—Any anæsthetic is poorly borne by patients who are in shock; moribund patients and those with profound cachexia or uræmia do not stand spinal anæsthesia well. We have, as will be demonstrated later, found shock to be the chief contra-indication to the use of tropacocaine.

(7) *Sepsis*.—Blood cultures showing the presence of sepsis definitely contra-indicate the use of spinal anæsthesia, due to the danger of exposing the meninges to bacterial contamination.

(8) *Massive Pleural Effusions and Intrathoracic Growths*.—These are contra-indications to spinal anæsthesia because of the possibility of respiratory embarrassment.

Preparation and Technic for Spinal Anæsthesia.—On the evening preceding the operation the patient is given a sedative, preferably one and one-half grains of luminal or three grains of amytal. As previously stated, all patients are given three-quarters of a grain of ephedrine sulphate by mouth forty-five minutes to one hour before operation, to be repeated immediately preceding the operation. The usual one-sixth grain of morphine sulphate with 1/150 of a grain of atropine sulphate is given one-half hour before operation.

Patients with hypertension are no exception to the rule of the preliminary use of ephedrine, since our experience has taught us that to omit it may lead to a sudden and marked drop in blood-pressure. Should it occur that during the course of the operation the systolic blood-pressure drops below 50, an additional dose of ephedrine is administered, sometimes with the addition of caffeine sodiobenzoate, depending upon the degree of shock.

Although the average drop in the systolic blood-pressure has been found to be from twenty to twenty-five millimetres in this series, we have noticed on a few occasions a drop to such an extent as to make the pressure unreadable, yet in these latter cases it was remarkable how quickly the pressure was elevated after an injection of ephedrine.

Spinal injection is usually made with the patient in the sitting posture. The lateral position is employed in patients who are too sick to sit upright. The level of injection chosen depends upon the type of operation to be performed. For operations below the level of the umbilicus, the site of injection was between the third and fourth or the second and third lumbar vertebræ. For operations above the umbilicus to the level of the diaphragm, the injection was made between the first and second lumbar vertebræ under

pressure, or between the twelfth dorsal and first lumbar vertebræ without pressure. We do not use spinal anæsthesia in operations involving structures above the level of the diaphragm.

In considering the degree of anæsthesia produced by tropacocaine hydrochloride, our records indicate that in 99 per cent. of our cases the anæsthesia was complete. The 1 per cent. of these cases in which the drug failed to produce anæsthesia may be attributed either to a possible non-susceptibility of the patient to tropacocaine or to a failure of the drug to reach the nerve roots because of anatomical hindrances to free circulation within the intra-arachnoid space. We do know, however, that when any difficulty is encountered in the course of the introduction of the needle into the spinal canal so that there is no free flow of spinal fluid into the barrel of the syringe before injecting the drug, that we do not get anæsthesia, or, at best, only an incomplete one. Inability to obtain a free flow of spinal fluid indicates that the tip of the needle has failed to enter the intra-arachnoid space, or the opening in the needle is partially occluded by a small shred of tissue, so that the solution upon injection does not come in direct contact with the nerve roots.

We have also observed that the presence of blood in the spinal fluid has a marked tendency to counteract the action of tropacocaine with no anæsthesia resulting. This is difficult to explain, although it is possible that blood has a neutralizing chemical effect upon the drug so that it fails to be absorbed by the nerve roots.

In about 95 to 96 per cent. of our cases, anæsthesia occurred either almost immediately or within three minutes after the injection of the tropacocaine solution, and lasted from one hour to one hour and fifteen minutes. In the remaining 4 to 5 per cent. the anæsthesia was delayed or did not occur.

Operative Complications.—Minor untoward effects which we have observed were retching and vomiting which occurred in about 10 per cent. of our cases. The more serious complications were anæsthetic shock and respiratory embarrassment.

Anæsthetic shock may be caused by a meningeal reflex from lumbar puncture, position shock occurring when the patient is suddenly changed from one position to another or from intracranial pressure. Varying degrees of shock were observed in 3 per cent. of the cases in this series, most of them incident to a sudden drop in the blood-pressure, which was controlled in most cases by increasing the Trendelenburg position, and the administration of ephedrine with or without caffeine sodiobenzoate.

Shock was manifested by a fall in blood-pressure, rapidity of the pulse, extreme pallor, shallow breathing and coldness of the extremities. In three of our cases, however, shock was the cause of death. Respiratory failure has been the cause of two deaths and was due to a paralysis of the motor nerves of respiration.

Post-operative Complications.—*Headache.*—Although in our early experience headaches were frequent complications, we now see them less frequently and in a milder form. Such headaches occur within a short time after

operation and may persist for some time. Since using the smaller calibre needles and adopting the Trendelenburg posture for at least forty-five minutes after the patient's return to the ward, the incidence has dropped to less than 5 per cent.

In order to understand the rationale of the treatment of headache, two types must be differentiated—the so-called lumbar puncture headache and the meningitic type.

(A)—*The Lumbar Puncture Headache*.—The more common headache is the lumbar puncture type, which is caused by the reduction of intraspinal pressure due to the seepage of spinal fluid through the opening in the dura made by the needle. The pain is, as a rule, referred to the occipital or parietal regions and appears within twenty-four hours after operation and has a tendency to increase in severity. Evans⁷ recommends in such patients the Trendelenburg posture for at least twenty-four hours, maintaining that in this position there is a greater tendency for the opening in the dura to be sealed by fibrin, thereby preventing further leakage of spinal fluid. The incidence of this type of headache can be greatly minimized by careful attention to technic and the use of small-calibre needles, thus reducing the danger of trauma.

(B)—*The Meningitic Type of Headache*.—This may be due to a meningismus, or to a low-grade meningitis, and most frequently follows a breach of technic. The incidence in this series of cases was one-fourth of 1 per cent. The headache is accompanied by rigidity of the neck and photophobia, and is not relieved by the Trendelenburg posture. The use of caffeine and sodiobenzoate intravenously has proven of great benefit in this type of headache, being used in conjunction with concentrated solutions of salines either by rectum or intravenously. Von Jaschke⁸ believes that such headaches occur less frequently when using simple aqueous solutions of tropacocaine than with solutions containing sodium chloride.

Nausea and Vomiting.—Nausea and vomiting occurred in approximately 3 per cent. of the cases in this series, and are thought to be the result of a cerebral anæmia. Gastric lavage and intravenous injections of a 10 per cent. glucose in saline solution are the methods we have employed in cases where nausea and vomiting have persisted for more than twenty-four hours.

Hiccup.—Hiccup may become annoying and intractable. It was encountered in 1.5 per cent. of the cases in this series and persisted for several days in each case. The condition may not have been the result of the anæsthesia, but rather of a uræmia or a diaphragmatic irritation of reflex origin.

Paralytic Ileus.—Paralytic ileus was encountered in only one case in this series. The condition may be difficult to distinguish from a generalized peritonitis.

Palsies.—Trauma to the nerve roots or cauda equina may produce transitory or permanent paralysis, with or without sensory disturbances. The transitory type which usually subsides in a few days occurred in one-half of

TROPACOCAINE SPINAL ANÆSTHESIA

1 per cent. of our cases, with permanent motor disturbances of the lower extremities resulting in but one case. The patient, white, male, aged fifty years, was laparotomized under general anæsthesia after an attempt was made with spinal technic. Due to a marked deformity of the spine, lumbar puncture was impossible. The usual small-calibre needle could not be used because of its flexibility. In this case the cord may have been injured in the course of the manipulations with the larger calibre needle. This patient, when examined about a year following the operation, was found to have a spastic paraplegia of the lower extremities.

Parotitis.—This complication is difficult to explain in view of the fact that it occurs also in inhalation anæsthesia. Parotitis has been met with in four of our cases. It was bilateral in one patient. We are of the opinion that it is in no way related to the use of tropacocaine.

Hyperpyrexia.—Hyperpyrexia occurred in one patient who was operated upon for an extensive carcinoma of the base of the bladder. It is our opinion that the anæsthetic was responsible for this condition since no other cause could be found to account for it. The elevation of temperature began immediately after operation, reaching 107° F. within thirty-six hours. The exact mechanism involved in this complication has never been clearly defined, but in our opinion may be due to a toxic action of the drug on the optic thalamus or heat centre.

Pulmonary Complications.—Pulmonary complications following operative procedures, although markedly reduced since our employment of spinal anæsthesia, have not been completely eliminated. We feel certain, however, that where pneumonia has followed the employment of tropacocaine hydrochloride, it was in no way related to the anæsthesia but to the debilitated condition of the patient prior to operation. The few cases of pneumonia or pneumonitis that have been observed in this series were always found in old men who had been operated upon for disease of the prostate gland.

Mortality.—In this series of 1,000 administrations of tropacocaine hydrochloride, there were only five deaths.

One of them was undoubtedly from shock due to hæmorrhage rather than from the effect of the anæsthetic. This occurred in a woman who died during the course of a subcapsular nephrectomy for recurrent calculous pyonephrosis. The operation was extremely difficult and prolonged because of the extensive adhesions due to a previous nephrotomy, and was accompanied by more than the usual amount of hæmorrhage. Death occurred at the close of the operation.

The second fatality was in a male, fifty-three years of age, with diabetes of long standing and gangrene of the right leg. His condition was extremely grave and he was practically moribund at the beginning of the operation. Death occurred before the completion of the operation and was due to respiratory failure. This patient was operated upon during our early experience with tropacocaine, and we feel that were he to present himself to us at the present time, spinal anæsthesia would not be our choice.

The third death in this series occurred in a man about fifty-six years of age, with an empyæma of the gall-bladder, who was referred for an emergency operation. He was short and stout, and his condition poor. Two ampuls of tropacocaine were given between the eleventh and twelfth dorsal vertebræ. Following the skin incision the blood-

pressure dropped below the reading point, and in spite of stimulation the pressure could not be elevated. The patient died of respiratory failure.

The fourth death occurred in a man fifty-four years of age with bilateral ureteral obstructive lesions, bilateral renal calculi, and an extremely poor kidney function. A pyelo-ureterotomy was performed on one side under tropacocaine anæsthesia with no untoward effect. About two weeks after the operation the temperature began to rise and the patient showed signs of an impending uræmia. Operation was undertaken to remove a large obstructing calculus from the left ureter. One and one-quarter ampuls of tropacocaine were administered between the first and second lumbar vertebræ. Following the skin incision there was an immediate drop in blood-pressure, the patient became cyanotic and death ensued immediately.

The fifth death occurred in a man fifty years of age, who had large obstructing calculi in the left ureter with pyonephrosis, and who had had two previous ureterotomies of that ureter for calculus. The temperature at the time of operation was 105° and the general condition of the patient was poor. One and one-half ampuls of tropacocaine were given in the first lumbar interspace. Following the skin incision, the patient became cyanotic and developed convulsive twitchings of the fingers and forearms, followed by respiratory embarrassment and finally respiratory paralysis. Death ensued within five minutes.

It is our belief that deaths which occur during spinal anæsthesia are primarily due to cardiac dilatation and respiratory failure. We are of the opinion that debility associated with high temperatures are factors definitely unfavorable to the employment of this type of anæsthesia. We believe that fever produces changes in the cardiac musculature and in the respiratory centre in the brain which tend to make patients more susceptible to the drug.

Final Analysis of Deaths.—Case I.—Undoubtedly shock due to hæmorrhage. Case II.—Anæsthetic death, due to respiratory failure. Patient was in pre-operative shock, and was a third-degree anæsthetic risk. Case III.—Anæsthetic death due to respiratory failure. Patient in pre-operative shock. In this case two ampuls of tropacocaine were given and there is a possibility that the patient may have had an idiosyncrasy to the drug. Case IV.—Death in this case was due to pre-operative shock (uræmia) with the anæsthetic as the contributing cause. A third-degree anæsthetic risk. Case V.—Anæsthetic death due to respiratory failure.

In these five casualties we have only two outstanding anæsthetic deaths. Two of these patients (Cases II and IV) would probably have died no matter what type of anæsthesia had been used. In the final analysis of all cases, we must consider, for our guidance in the future use of tropacocaine, all factors that may have an unfavorable as well as favorable bearing on our judgment. Our experience in this series has left us with a distinctly favorable impression and we feel assured that, in the knowledge we have gained, tropacocaine in the future will show even better results.

One of the writers of this paper is a recognized anæsthetist of over thirty years' experience in the practice of anæsthesia as a specialty who, having tried spinal anæsthesia some twenty-five years ago without much success, was rather reluctant to employ it again about five years ago, but

TROPACOCAINE SPINAL ANÆSTHESIA

numerous requests from surgeons for this method of anæsthesia made it obligatory that he perfect himself in the technic.

After using various agents recommended for spinal anæsthesia, he, with the co-authors of this paper, has come to the conclusion that the best results in spinal anæsthesia are obtained from the use of tropacocaine hydrochloride, their judgment being based on the following observations:

(1) Tropacocaine is a safer and more dependable agent for spinal anæsthesia than other agents we have employed.

(2) The ease with which it is administered is of decided advantage.

(3) It is free from marked untoward effects.

(4) Compared with other agents there is a diminished degree of shock, both operative and post-operative, which is noteworthy.

(5) There is a lessened degree of nausea and vomiting when tropacocaine is used compared with other products.

(6) A lessened incidence and severity of headaches is also noted in comparison.

(7) It is rapid in action. In 95 per cent. of our cases, anæsthesia occurred either immediately or within three minutes after the injection of tropacocaine.

(8) In 99 per cent. of our cases the anæsthesia was complete.

(9) The satisfactory duration of the anæsthesia.

(10) Finally, the marked contrast of the physical comfort and mental attitude of the patient as compared to general anæsthesia.

BIBLIOGRAPHY

- ¹ Chadbourne, A. P.: *Über Tropakokain, ein Benzoyl-pseudotropein, eine neue Koka-base, und dessen Wert als lokales Anesthetikum.* *Therap. Monatsh.*, p. 471, 1892.
- ² Schwarz, K.: *Zur Frage der medullaren Narkose.* *Vorl. Mitt. Centralbl. f. Chir.*, No. 9, 1901.
- ³ Meyer, Willy: *Tropacocaine Hydrochlorate—A Substitute for Cocaine Hydrochlorate in Spinal Anæsthesia.* *Med. News*, pp. 569–572, April 13, 1901.
- ⁴ Neugebauer, F.: *Über Rückenmarksanalgésie mit Tropakokain.* *Wien. klin. Woch.*, Nos. 50–52, 1901.
- ⁵ Kopfstein, W.: *Erfahrungen mit der spinalen Anesthesie nach Bier.* *Wien. klin. Rundsch.*, No. 49, 1901.
- ⁶ Sollmann, Torald: *A Manual of Pharmacology.* Fourth edition, p. 2, Saunders & Co., 1932.
- ⁷ Evans, Charles H.: *Spinal Anæsthesia, Principles and Technic.* First edition, p. 127, Hoeber, N. Y., 1929.
- ⁸ von Jaschke, Rud. Th.: *Lumbar Anæsthesia—the Best Anæsthesia Procedure in Gynecology.* *Schmerz-Narkose-Anesthesia*, No. 1, April, 1931.

TORSION OF THE OMENTUM *

BY CHARLES E. FARR, M.D., AND R. F. BACHMANN, M.D.

OF NEW YORK, N. Y.

TORSION of any organ is rather uncommon. It is of interest chiefly from the etiological standpoint and from the variety of symptoms produced. The pathological findings are fairly simple, the end-results well known. The prognosis depends upon the tissue or organ involved and upon timely surgical intervention.

Torsion of the omentum is probably more common than is generally appreciated. Corner and Pinches,¹⁰ in 1905, were able to collect only fifty-one authentic cases. Morris,¹⁶ in 1932, added 160. Probably every surgeon of experience has had one or more but few are reported. For this reason the following seven cases are given in some detail—five collected from the First Surgical (Cornell) Division of the New York Hospital and two observed by one of us (Bachmann) at the Burbank Hospital, Fitchburg, Massachusetts. Our most appreciative thanks are hereby expressed to the various operating surgeons for the privilege of reporting their cases.

CASE I.—(DOCTOR FARR, New York Hospital.) D. C., an obese Italian male of twenty-one years, a chauffeur, entered the hospital January 31, 1932, complaining of a sharp pain in the right upper abdomen of three days' duration. Onset acute while driving auto. Pain constant, unrelated to meals, non-radiating, unaccompanied by nausea and vomiting or symptoms of collapse, but gradually increasing in severity until admission. At no time was there any nausea or vomiting, jaundice, gaseous eructations or other symptoms of gastric distress. Bowels slightly irregular of late; stools normal in color and consistency. Moderate tenderness in the right upper quadrant. No history of previous attacks. His abdomen was rather obese with a firm anterior wall. Tenderness with slight rigidity in the right upper quadrant where an indefinite sensation of a mass was elicited. Rebound tenderness was referred to the right upper quadrant. No herniæ. Leucocytes 15,400; polymorphonuclears, 72 per cent.; temperature, 99.2°; pulse, 80; blood-pressure, 116/32; icteric index, 10.3; urine, negative. A provisional diagnosis of acute cholecystitis was made and operation performed.

Operative Findings.—Moderate amount of free clear fluid on opening abdomen. The great omentum was divided into strands of which one had a very large terminal portion. This had become twisted about five times clockwise. It was gangrenous and the gangrenous portion was a flat disc about ten by eight by one-half centimetres. To this gangrenous omentum was attached another of the tongues of the healthier omentum, evidently a recent attempt to protect the gangrenous portion. Both pieces of omentum resected by double ligation. Exploration negative except for the appendix which was somewhat injected. There was a raw area on the appendix which was bleeding slightly, suggesting that the omentum had been attached to it and torn loose by manipulation. Appendix was removed by double inversion. Closure without drainage.

Pathological Report.—Chronic obliterative appendicitis and twisted omentum with hæmorrhage. Microscopical examination of omental tissue showed congestion of vessels and scattered small extravasations of red blood-cells.

* Read before the New York Surgical Society, November 9, 1932.

TORSION OF THE OMENTUM

Post-operative Course.—Uneventful except for development of slight cough on third day. Stitches removed and dressing changed on sixth day. He was seen May 12, 1932, and was in excellent health.

CASE II.—(DOCTOR FARR, New York Hospital.) H. P., a male adult of forty-eight years, admitted to the hospital July 6, 1931, complaining of acute pain in epigastrium of one day's duration, severe and constant with no radiation. He continued to work and slept that night. The next day he tried to work and could not stand erect because of the pain. There was no vomiting.

The past history showed much belching of gas for three years with periods of freedom from discomfort. He was troubled with constipation for about one year.

Physical examination was negative except for definite rigidity in the right upper quadrant and epigastrium. There was severe pain on pressure in the epigastrium and rebound tenderness. No masses were felt. The leucocytes were 10,700; polymorphonuclears, 69 per cent.; temperature, 100.6°; pulse, 76; respirations, 20. Urinalysis was negative. The flat plate of the abdomen was negative save for hypertrophic changes in the lower lumbar spine. A preliminary diagnosis was made of subacute cholecystitis or perforating peptic ulcer.

Operative Findings.—No ulcer could be found and there was no free gas. The gall-bladder was normal. In the mid-line of the epigastrium was an omental tag of the lesser omentum, about three inches long, which hung down in the region of the pylorus and was slightly adherent to the adjacent viscera. It was freed and elevated and was found to have twisted 720° clockwise; three centimetres of the distal portion were gangrenous. The omental tag was removed after ligation of the base. Complete exploration of the abdomen was negative except for a small Meckel's diverticulum about two feet above the ileocecal valve. It bore no relation whatever to the gangrenous omentum. The appendix was normal and was not disturbed.

Pathological Report.—Only a hæmorrhagic tag of omentum. It is brown-red due to hæmorrhage beneath the surface and deep in. On frozen section there is much necrosis. The outlines of the fat cells are not distinct, but are suggested by the network of capillaries.

CASE III.—(DOCTOR CORNELL, New York Hospital.) H. W., a male adult of thirty-three years, admitted to the hospital September 10, 1927, complaining of sharp pain in the right lower abdomen of three days' duration. Onset of pain was sudden; pain was intermittent in character, but gradually increased in severity. He was slightly nauseated, but did not vomit. Bowels were constipated; no urinary symptoms.

Rigidity in the right lower quadrant of abdomen with tenderness and a suggestive mass. There was slight resistance in the left side of the abdomen, but very little tenderness. Rectal examination was negative except for tenderness in the right gutter. Temperature, 100°; pulse, 80; leucocytes, 12,000; polymorphonuclears, 76 per cent.; urine, negative. *Diagnosis.*—Acute appendicitis.

Operative Findings.—Appendix long, adherent and containing concretions; it was removed. Exploration of abdomen revealed that omentum was twisted and tip bluish-red in color. This was delivered into wound and found twisted nine times. Ligated and removed gangrenous area.

Pathological Report.—Infarcted fat—hæmorrhage and twisting of the omentum; sclerosed appendix.

Post-operative Course.—Patient had some discomfort (pain) first two days. After that recovery uneventful. Patient discharged cured on ninth day.

CASE IV.—(DOCTOR WEEDEN, New York Hospital.) L. S., a woman of thirty-two years, admitted to the hospital September 29, 1925, complaining of abdominal pain of forty-eight hours' duration. She had had a mild pain in the right lower quadrant two days before; twenty-four hours later it became severe, localizing in the right lower quadrant and epigastrium. Pain did not radiate to the shoulder, back or groin. No nausea nor

vomiting. Appetite, good; constipated. No jaundice. No previous attacks. Family and past histories negative.

Marked tenderness and moderate rigidity to deep palpation in the right lower quadrant over McBurney's point. The tenderness extended up the right side as far as the umbilicus. There was slight tenderness in the right upper quadrant over the gall-bladder. Left side negative. Urine showed trace of bile; leucocytes, 12,200; polymorphonuclears, 72 per cent.; temperature, 101°; pulse, 96. *Pre-operative Diagnosis*.—Acute appendicitis.

Operative Findings.—As peritoneum was opened a mass of omentum about six inches long and three inches wide which came from the transverse colon was found to be very much inflamed and somewhat necrotic. No reason for this condition could be found, as the omentum was not in contact with any other organ and there was no demonstrable twist of the pedicle. It was removed after ligation. Gall-bladder was swollen to half again normal size, walls were considerably thickened and it contained numerous stones. It was removed. Closure with drainage.

Pathological Report.—Cholecystitis subacute and cholelithiasis; peritonitis fibrinopurulent—piece of omentum eight by five centimetres, much thickened, dark brown in color and in parts almost black. Microscopically showed marked engorgement of vessels, large blood extravasations in the interlobular connective tissue of omentum. Peritoneal covering of omentum much thickened by a fibrinopurulent infiltration of sub-endothelial connective tissue. This infiltration extended into neighboring fatty tissue.

Post-operative course.—Uneventful recovery. Discharged cured on fourteenth day.

CASE V.—(DOCTOR HITZROT, New York Hospital.) A. F., a woman of forty years, admitted to the hospital September 23, 1920, with intense pain in the right upper quadrant of the abdomen radiating to the right scapular region and left side, existing ever since discharge following first admission two months previously, at which time a diagnosis of cholelithiasis was made, although no definite evidence of gall-stones could be shown by X-ray. X-ray at that time was also negative for renal calculus, and any organic change in stomach or duodenum. Pain had existed for past seven months, especially after eating. She had considerable gas on stomach; unable to raise it. Nauseated but did not vomit. No jaundice except in scleræ. Difficulty in breathing during attacks. Since last admission pain has increased in severity and frequency. A very well-developed and well-nourished female of forty years, appearing in some pain. Abdominal examination showed moderate tenderness in the right upper quadrant, very severe in epigastrium just below xiphoid. Upper half of right rectus rigid. No organs palpated; no masses definitely felt, though there was an indefinite sense of a mass in the right upper quadrant. Stools normal. Urine showed a trace of bile. Leucocytes, 15,000; polymorphonuclears, 81 per cent.; temperature, 99°; pulse, 80. *Pre-operative Diagnosis*.—Acute cholecystitis.

Operative Findings.—On opening abdomen, gall-bladder seemed a little distended, but it was not adherent, contained no stones, and emptied quite readily. Further exploration showed an inflamed piece of fat attached to the gastrohepatic omentum and adherent to the suspensory ligament of the liver. After freeing this from the ligament an inflamed piece of fat was found plastered down on the anterior wall of the stomach in the region of the lesser curvature. After freeing it from this region, the stomach wall, except for a superficial irritation, was not involved and there was no evidence of any lesion in the stomach wall on careful examination. The piece of fat evidently originated from a pedicle which had become twisted, there being at least three turns in the pedicle. The fat itself was hæmorrhagic. Fat was excised between ligatures. Further exploration of the abdomen showed an appendix which was bound down at its base by a band of adhesions. The appendix was removed and its base inverted by double row of chromic. Examination of the uterus was negative. No cause for the symptoms was found other than the piece of strangulated fat above described. Abdomen closed without drainage.

Pathological Report.—Appendix showed nothing remarkable. Piece of fat, dark red

TORSION OF THE OMENTUM

in color, one and one-half by three by three centimetres; it had a short pedicle, around which the specimen had rotated, producing infarction of the fat.

Post-operative Course.—Recovery uneventful. Discharged cured on the thirteenth day.

CASE VI.—(DR. P. O'DEA, Burbank Hospital, Fitchburg, Mass.) M. H., a female of fifty-six years, entered the hospital in August, 1931, complaining of abdominal pain of four days' duration. Onset gradual, beginning as a dull ache in the lower abdomen, aggravated by walking. No nausea. Pain relieved by lying down. Bowels regular. No previous attacks. On morning of admission while walking she was seized by a very acute pain in the right lower abdomen, so severe she felt faint. She went to bed and the pain subsided; but she had a feeling that if she got up and walked she would have a recurrence of pain.

Some tenderness on palpation over the whole lower abdomen, most marked over right groin. No spasm. Rectal examination showed uterus to be small and movable; a mass was felt posterior to uterus, very tender, quite hard and not attached to uterus. Temperature, 97.4°; pulse, 99; respirations, 20. Urine showed one plus albumen, many leucocytes and pus, much epithelium. Leucocytes, 11,600; polymorphonuclears, 75 per cent. *Pre-operative Diagnosis.*—Undetermined; exploratory laparotomy decided upon.

Operative Note.—(Dr. R. H. Miller, of Boston.) Uterus contained one fibroid in fundus, size of cherry. Behind uterus a firm boggy mass which turned out to be a lump of semi-necrotic omentum about the size of an egg. Pedicle twisted on itself three to four times. Mass easily removed. Fibroid enucleated. Appendix not remarkable; removed.

Post-operative Course.—Uneventful recovery.

CASE VII.—(DR. G. P. NORTON, Burbank Hospital, Fitchburg, Mass.) G. Q., a woman of thirty-seven years; admitted to the hospital August 7, 1931, complaining of abdominal pain of a few hours' duration. She was suddenly seized with pain in the epigastrium, and vomited; the pain continued, but two hours later it localized in the right lower quadrant with tenderness throughout. Patient gave history of previous attacks of abdominal pain. Abdominal examination revealed tenderness in the right lower quadrant with some spasm; otherwise negative. Temperature, 100.4°; pulse, 76; respirations, 20; urine, negative; leucocytes, 12,000; polymorphonuclears, 85 per cent. *Pre-operative Diagnosis.*—Chronic appendicitis.

Operative Findings.—Twisted piece of omentum that was very much discolored and beginning to become gangrenous, about size of an egg. This mass was ligated and removed. Appendix long and inflamed, and tied down almost its entire length; removed in routine manner. Uterus and adnexia normal in size and position. Gall-bladder palpated; it was tense and stones could be palpated in it. Because of patient's condition and the great amount of fat, it was deemed advisable not to do any further operative procedure. Abdomen closed in layers.

Post-operative Course.—Uneventful recovery. Discharged on thirteenth day.

None of the cases were associated with hernia; it is true that in some of them the presence or absence of hernia is not stated, but it is assumed that such a pathological finding was not present. The same may be said of the presence or absence of free fluid in the peritoneal cavity upon opening the abdomen. Thus, the torsion was either idiopathic or associated with some other intra-abdominal pathological process, although in some of the cases it seems a little difficult to decide the exact status.

In addition to the above cases the senior author has seen on several occasions omental and epiploic tags which gave some, but not conclusive, evidence of having undergone torsion. It is quite probable that such occurrences are not rare. They may account for some of the evanescent attacks of abdominal pain, slight fever and malaise which are so difficult to explain.

To us the most interesting feature of torsion is its etiology. All torsions seem to occur in closed cavities, with low atmospheric pressures and smooth gliding surfaces. Such factors are common to torsion of the ovary, perhaps the most common of all, the testis, the tubes, the appendix, the bowel and finally the omentum. All are attached at one or both ends. The shape of ovary and testis is not unlike, the others are quite diverse. All have some sort of pedicle formation. All contain arteries, veins, lymphatics and nerves. All are subject in varying degree to external forces and changes in pressures, by muscular action, by the diaphragm, by the abdominal wall or by peristaltic wave. External violence as from blows, falls, manipulations, *etc.*, is common to all. Change of body position affects all alike.

Change in tissue structure or density preceding torsion may conceivably be a factor, for example, mild inflammations, œdema, adhesions, excess deposit of fat. Surely such factors are pre-disposing only.

The inciting cause of the first quarter turn (90°) is very easy to understand. Any change in body position, in intra-abdominal pressure, or any sudden increase in peristalsis, could easily rotate an organ in unstable equilibrium one-quarter turn. Why does the twisting continue, even to the point where untwisting becomes difficult or impossible? Many theories have been advanced, mostly based on the continued application of the forces above mentioned. Aside from peristaltic action, which is very impressive to one who has observed it on the operating table, these forces do not appear sufficient. They are either too feeble or not continuous enough, or have too little point of application, to effect complete torsion and strangulation.

Our only remaining common factors in organs subject to torsion are the structures themselves, namely the blood-vessels, lymphatics and nerves. Of the last it may be stated that we know little. It is conceivable, however, that they are able to send messages of distress which call for increase or at least change of action, principally as to blood supply and peristaltic motion.

Lymph flow must have considerable bearing. When retarded by even one-quarter turn of the pedicle, stasis results, œdema begins, the weight of the organ increases, and a tendency to sag, possibly even to twist can easily be imagined.

This tendency is much more pronounced in the case of the blood-vessels. The arteries are shorter than the veins, firmer, thicker walled. A beginning twist will cut off venous return long before arterial supply is greatly impeded. The veins distend, become tortuous and begin to wind around the arteries. The process of rotation is thus carried on, probably accentuated by hyperperistaltic action in neighboring organs, possibly aided also by muscular overactivity of the diaphragm, the abdominal wall, *etc.* In the meantime, passive congestion increases the weight of the organ and hinders any tendency to right itself. Œdema is increased, hæmorrhages occur and finally infarction. Atrophy, complete necrosis or gangrene, or infection and peritonitis may be the end-results.

TORSION OF THE OMENTUM

We must confess that no one of these various hypotheses seems adequately to account for torsion of the extreme degree not rarely seen. Probably a combination of forces, rather than any one, is responsible.

Elaborate classifications of torsion of the omentum have been proposed by several authors, notably Morris.¹⁶ They are, in general, based on the presence or absence of hernia as an underlying cause and on the question of one pedicle or two, that is, whether the omentum is attached by adhesions to a hernial sac or ring, or to some other part of the peritoneal lining. The natural classification of acute or chronic or recurrent type is also used.

The symptomatology of torsion of the omentum presents no outstanding characteristic or pathognomonic features. Perhaps the one striking observation in our series is that the surgeon was never convinced of the accuracy of his pre-operative diagnosis. The signs and symptoms, the history and the laboratory findings pointed to an intra-abdominal surgical emergency but never to a definite positive diagnosis. The correct diagnosis was never made, never even suggested or considered. It is perhaps only fair to state that in this series hernia did not appear.

Diagnosis of torsion of the omentum has seldom been made pre-operatively. The presence of a hernial orifice, a history of pre-existing, easily reduced hernia, and the finding of a soft, rather doughy mass in the right abdomen, are suggestive. The remaining signs and symptoms with the laboratory findings point only to an intra-abdominal lesion of moderate intensity but without indications as to the specific organ involved. The absence of nausea and vomiting, the low leucocyte and polymorphonuclear percentage, the relatively mild reaction to palpation in our series are interesting observations.

The prognosis in omental torsion is quite favorable if timely surgical intervention is instituted. There was no mortality in our cases. The natural risks from anæsthesia and laparotomy in stout people of adult years must be considered. Post-operative pneumonia, embolism, wound infection, peritonitis are ever-present dangers.

The treatment is purely surgical. It consists of removing the strangulated mass and covering the stump with peritoneum if possible. Any attempt at untwisting is unwise, usually is impossible.

CONCLUSIONS.—(1) Torsion of the omentum is an abdominal condition occurring more frequently than is ordinarily supposed; it is difficult to diagnose pre-operatively, but would probably be recognized more frequently if considered more often in the differential diagnosis of abdominal pain.

(2) Torsion may occur without apparent cause (so-called primary idiopathic torsion) or may be secondary to other pathological processes, such as inflammation, neoplasia and hernia.

(3) The condition is especially apt to occur in obese or well-nourished individuals, and may be initiated by abdominal trauma or severe physical exertion.

(4) The symptoms and signs are those of peritoneal irritation plus the rapid formation of a mass, palpable in many cases.

(5) Torsion is most often confused with acute appendicitis with appendiceal abscess; less frequently with acute cholecystitis. In cases associated with hernia it is often diagnosed as incarcerated or strangulated hernia.

(6) The prognosis is excellent with timely surgical intervention. Stout, middle-aged patients are poor surgical risks at best. The mortality is due to complications.

BIBLIOGRAPHY

- ¹ Aimes: Quoted by Morris¹⁰; also Cowell.³
- ² Mauclaire: Quoted by Mullen.¹³
- ³ Cowell: Abdominal Torsion of the Omentum. *Brit. Surg. Jour.*, vol. xii, pp. 738-751, 1924-1925.
- ⁴ Oberst: Quoted by Morris¹⁶; also D'Errico.¹⁶
- ⁵ Demons: Quoted by Morris.¹⁶
- ⁶ Bayer: Quoted by Jeffries.¹⁷
- ⁷ Eitel: Quoted by Morris,¹⁶ D'Errico,¹⁶ *etc.*
- ⁸ Hochenegg: Quoted by Cowell.³
- ⁹ Scudder: Intra-abdominal Torsion of the Entire Great Omentum. *ANNALS OF SURGERY*, vol. xl, p. 916, 1904.
- ¹⁰ Corner, and Pinches: *Amer. Jour. Med. Sci.*, vol. cxxx, pp. 314-329, 1905.
- ¹¹ Lejars: Quoted by Cowell.³
- ¹² Fuller: Quoted by Mullen.⁴³
- ¹³ Mullen: Torsion of the Great Omentum. *Surg., Gynec., and Obst.*, vol. xl, pp. 635-641, 1925.
- ¹⁴ McWhorter: Torsion of the Omentum without Hernia. *Arch. Surg.*, vol. xvi, pp. 569-582, February, 1928.
- ¹⁵ D'Errico: Primary Torsion of the Great Omentum. *N. E. Jour. of Med.*, vol. cciii, No. 24, pp. 1181-1188, December 11, 1930.
- ¹⁶ Morris: Torsion of the Omentum. *Arch. Surg.*, vol. xxiv, No. 1, pp. 40-76, January, 1932.
- ¹⁷ Jeffries: Torsion of the Great Omentum. *ANNALS OF SURGERY*, vol. xciii, No. 3, pp. 761-765, March, 1931.
- ¹⁸ Picquet: Quoted by Cowell.³
- ¹⁹ Bierman, and Jones: *Surg., Gynec., and Obst.*, vol. xxxvi, p. 708, 1923.
- ²⁰ Studebaker: Quoted by Morris.¹⁰
- ²¹ Palmer, and Hardman: Strangulated Epiploic Appendix Simulating Appendicitis. *ANNALS OF SURGERY*, vol. xciv, pp. 1118-1120, 1931.
- ²² Watson: Quoted by Mullen.¹³
- ²³ Anderson: Torsion of the Great Omentum. *Jour. Am. Med. Assn.*, vol. xcvi, pp. 1227-1228, April 11, 1931.
- ²⁴ Thorek: Primary Torsion with Report of Case. *Med. Jour. and Rec.*, vol. cxxxiii, pp. 526-528, June 3, 1931.
- ²⁵ Huff: Torsion. *Va. Med. Monthly*, vol. lvii, pp. 583-584, December, 1930.
- ²⁶ Tait: Quoted by Mullen.¹³
- ²⁷ Robinson: Quoted by Mullen.¹³
- ²⁸ Baldwin: Quoted by Cowell.³
- ²⁹ Draper, and Johnson: The Pathologic Omentum. *Jour. Am. Med. Assn.*, vol. lxxxviii, pp. 376-379, February 5, 1927.

BILATERAL SNAPPING THUMBS

By EDWARD L. COMPERE, M.D.

OF CHICAGO, ILL.

FROM THE DIVISION OF ORTHOPÆDIC SURGERY OF THE UNIVERSITY OF CHICAGO

CHRONIC traumatic and inflammatory lesions of the tendons and tendon sheaths of the hand are not uncommon and are often quite disabling, yet there are few reports of these cases and the American literature is surprisingly silent upon the subject. Snapping index or "trigger fingers" are occasionally seen in any large clinic, while the stenosing tendovaginitis at the radial styloid process which was first reported by de Quervain, in 1895, and recently reviewed with an excellent résumé of the cases in the literature by Finkelstein, is still more common. De Quervain declared that the condition occurred only in the tendon sheath of the abductor longus and extensor brevis pollicis tendon. A similar lesion which involved the tendon or tendon sheath of the flexor pollicis longus muscle was described by Paulson, Nussbaum, Troell, and Finkelstein (Case X), while Hauck, in 1923, and Kroh, in 1925, described the only cases of bilateral tendovaginitis of the m. flexor pollicis longus with snapping thumbs that I have been able to find in the literature. These authors have also noted similar lesions of other tendons of the hand.

Because there is so little general knowledge of this subject the condition has been erroneously diagnosed as rheumatism, neuritis, periostitis, tenosynovitis, tuberculous osteitis, or, as in the case reported here, chronic recurring dislocation at the distal interphalangeal joint.

Report of Case.—A woman, aged twenty years, came to the University of Chicago clinics on April 15, 1930, because of "locking" of the distal phalanx of both thumbs. The patient stated that since the age of three or four years she had had difficulty in flexing the distal phalanx of both thumbs, and, when flexed, she was often unable to extend this phalanx without assistance from the opposite hand. Upon either flexion or extension there was always a visible jerk and a snap or click was often noted. The patient was a skilled pianist and not only was the disability a handicap to her but after an hour or more at the piano the thumb became quite painful and the difficulty in either flexion or extension became much more marked. Numerous medical consultations had failed to explain or relieve the condition. As a result of the disability she had been compelled to give up her position as a teacher of the piano. With the exception of the disability described, the past history was not relevant.

An examination of the hands revealed an entirely normal appearance, but flexion of the distal phalanx of either thumb was possible only with considerable effort and was accompanied by a snap or click. The initial impression was that this was a case of recurrent dislocation which accompanied each *flexion* of the phalanx. However, when the tendon of the flexor pollicis longus muscle was palpated, a firm nodule was detected near the base of the thumb which moved with the tendon and seemed to snap abruptly back and forth in the sheath with a palpable click upon flexion or extension of the distal phalanx. It seemed probable that this was a condition analogous to the more common one of snapping index finger, or "trigger finger." Since there is a transverse band

across the tendon sheath just at the level of the tendon nodule, it was thought probable that the phenomenon was due to the difficulty in passage of the nodule through the narrow portion of the tendon sheath. The nodules proved to be radiolucent. Other laboratory tests were normal. A diagnosis of tendonitis stenosans of the flexor pollicis longus tendons, bilateral, was made.

Operation was performed on both hands May 27, 1930. The approach was through an incision on the outer side of the thumb, extending from the distal interphalangeal joint proximally to the base of the first metacarpal bone. By reflecting the medial flap the sheath of the flexor pollicis longus tendon was exposed. The sheath was opened longitudinally to the transverse volar ligament which was incorporated in the tendon sheath as a dense transverse band of fibrous tissue which constricted the sheath and tendon. When traction was applied to the tendon distal to the constriction band, there was a definite resistance and then with an audible click a nodular, fusiform

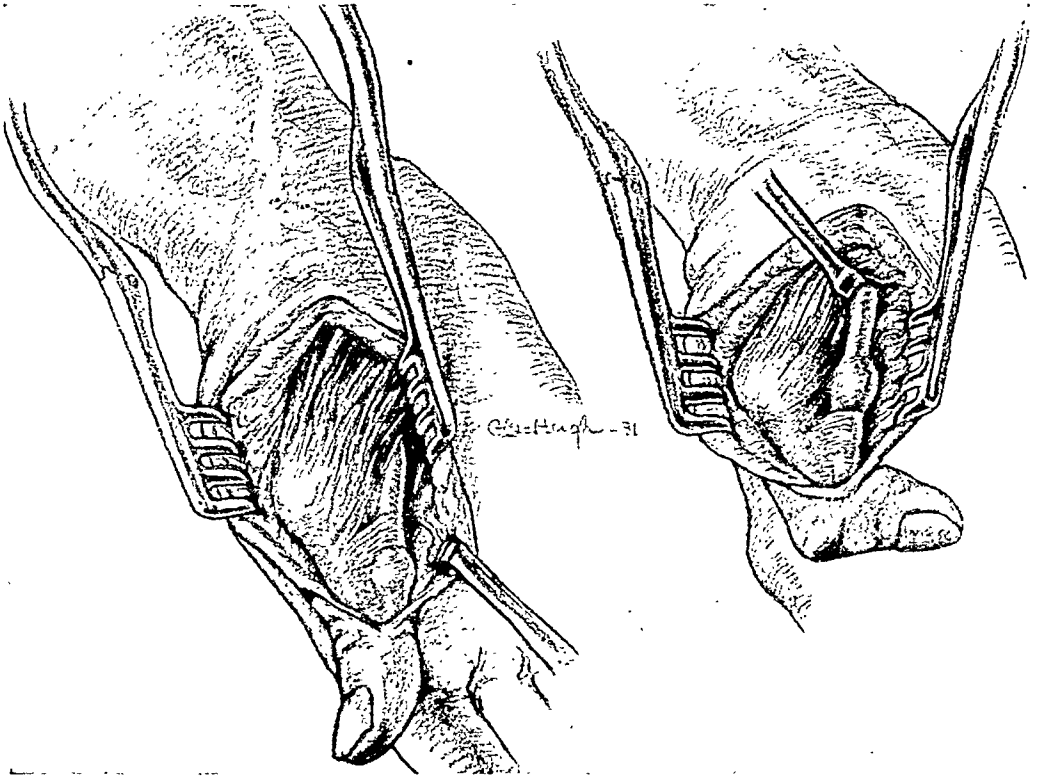


FIG. 1.—Diagram illustrating the nodule in the tendon of the flexor pollicis longus muscle. When the distal phalanx of the thumb was extended the nodule was distal to the transverse fibrous band. When the thumb was flexed at the distal interphalangeal joint the nodule was drawn through the constricted portion of the sheath to the proximal side of the fibrous band.

swelling in the tendon snapped into view. This nodule was one centimetre in length and more than twice as thick as the diameter of the tendon itself. The tendon fibres were rough and frayed from the constant friction of forcing this nodule through the narrow portion of the tendon sheath. When the thumb was now forcibly extended the nodule was pulled up out of sight and again the snap or click was both heard and palpated. (Fig. 1.)

The tight transverse band was divided and part of the sheath was cut away as far as the point at which the tendon disappeared beneath the short muscles of the thumb. (Fig. 2.) The tendon was then split open through the fusiform swelling and about half of the nodular portion of the tendon was excised and the slit in the tendon was closed. It was then possible to extend and flex the thumb without any difficulty and both the jerk and the click had disappeared.

SNAPPING THUMBS

A similar procedure was carried out on the right hand and an identical condition was found, although the nodule in the tendon was larger than that on the left side.

The patient made an uneventful recovery and she was discharged from the hospital six days after the operation.

Physiotherapy was continued for two weeks and when she returned to the clinic on June 25, 1930, one month after operation, the range of motion was normal and there was no "click." Two months after operation, July 25, 1930 (Fig. 3), there was no pain, stiffness, or tenderness in either thumb and she reported that she played the piano with greater freedom than she had ever been capable of before the operation. In December, 1930, seven months after operation, the patient reported that she was again teaching piano and that there had not been the slightest return of the disability. At the time of the last visit, September 28, 1931, the range of motion and function of the thumbs was entirely normal.

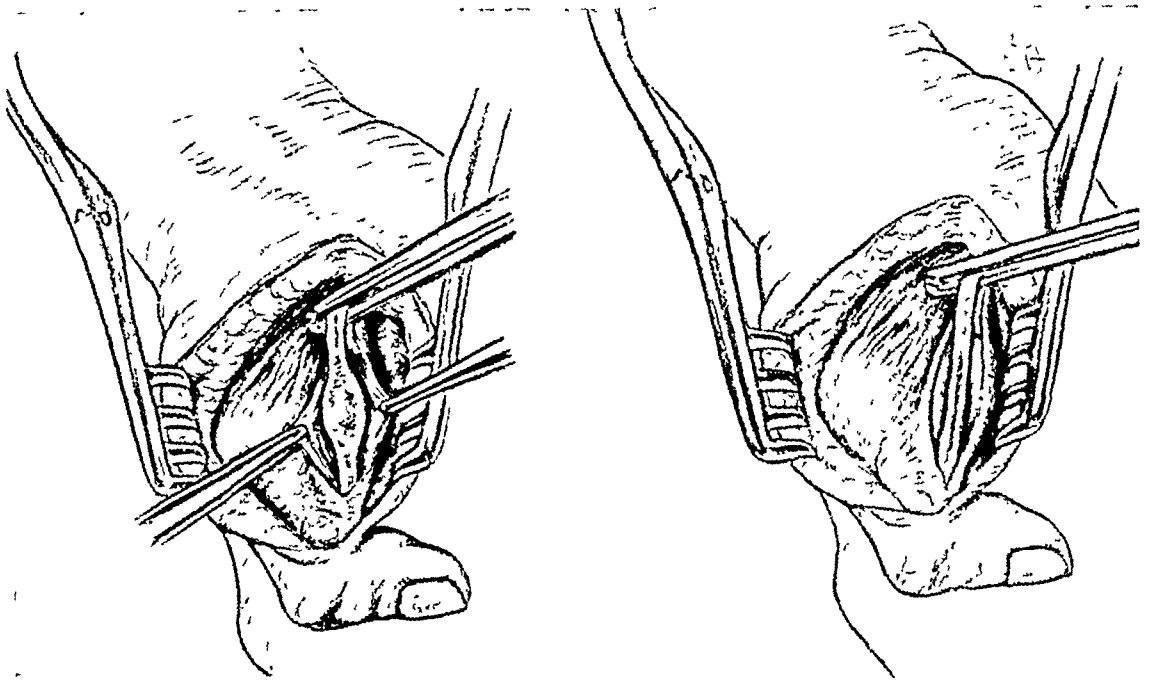


FIG. 2.—The sheath has been opened and part of the constricting band has been cut away. The second illustration shows the appearance of the tendon following excision of the central portion of the "tumor."

A microscopical study of some of the tissue removed from the fusiform nodules revealed numerous cartilage-like cells among the dense fibrous tissue of the tendon.

Comment.—The etiology of tendonitis stenosans has been attributed to chronic trauma and in cases previously reported the onset of the symptoms has usually been in older patients. Finkelstein's case was fifty years of age and the disability had been noted only sixteen months. At operation a fusiform swelling one centimetre long was found in the m. flexor pollicis longus tendon at the metacarpo-phalangeal joint of the right thumb. Troell studied the case of a piano teacher, sixty-four years of age, who had, in addition to tendovaginitis at the radial styloid process, a "doigt à ressort" or snapping finger on the middle finger of the opposite hand. A second case, also a woman, aged fifty-six years, had for four years had a snapping of the flexor pollicis longus tendon as well as a tendovaginitis stenosans at the radial styloid process. Troell also felt that chronic trauma was the most obvious etiological factor.

Poulsen reported fifteen similar cases, and in five of these a small tendon tumor was found in the long flexor tendon of the thumb. Nussbaum reported stenosis of the sheath of the flexor longus pollicis tendon without a tendon tumor.

Kroh described seven cases with involvement of the long flexor of the thumb with difficulty in flexion or extension of the distal phalanx and definite "snapping"

upon such motion. Of seven additional cases involving the flexor tendons of the fingers, the audible snapping was noted in four while in three there was only difficulty in flexion and extension associated with pain upon motion without the snapping. Kroh's cases included a male child aged two and one-half years with involvement of the left thumb and a female aged three and one-half. The duration of symptoms in each case was two to three weeks and in each instance a nodule was found in the flexor pollicis longus tendon. In a third case, aged forty-eight years, the disability was bilateral and had been present for six weeks on the left hand and two years on the right. Hauck also found this condition in two young children, both females, aged two and three and one-half years, respectively. In a total of four cases the disability was due to a nodule in the flexor pollicis longus tendon and was associated with definite snapping. In eight additional cases there was snapping and difficulty upon flexion and extension of the distal phalanx of the thumb, but the pathology present at operation consisted of thickening or contracture of the sheath of the m. flexor pollicis longus tendon without a nodule or tumor of the tendon itself.

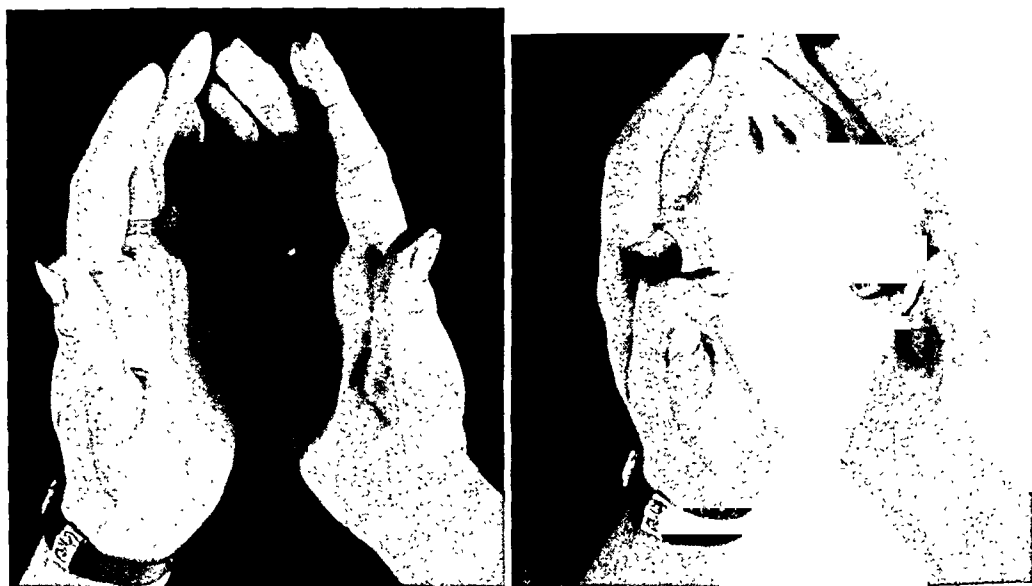


FIG. 3.—Normal voluntary flexion and extension of the thumb, July 25, 1931, two months after operation.

In a review of the literature forty cases were studied. In each of these cases the disability consisted of difficulty in flexion and extension of distal phalanx, associated with pain and "snapping" upon motion. In seventeen of the forty cases nodules were found in the flexor pollicis longus tendons, and, in two of these, one reported by Kroh, aged forty-eight years, and a second by Hauck, aged three years, the condition was bilateral.

The ages varied from two years to seventy-one years. There were eight patients six years or younger, but only two of the other patients were less than forty years of age.

The disability is far more common in the female, since there were only four males in the series, thirty-three females and three cases in which the sex was not clearly stated.

Most of the patients were treated by operation in which part of the sheath was cut away, permitting free motion of the enlarged portion of the tendon.

SNAPPING THUMBS

In every instance complete relief from symptoms was reported, while attempts to treat the condition conservatively before advising operation had been uniformly unsuccessful.

The etiology of the condition is doubtful. The occurrence in very young children would indicate a congenital basis but most of the patients were more than forty years of age and the duration of the symptoms in these patients was from four weeks to two years. In some of the cases, as in our own, the slight enlargement of the tendon may have dated from intra-uterine life, while the constant use of the thumb not only may have contributed to irritation, thickening and narrowing of the tendon sheath, but caused further enlargement of the tendon nodules themselves.

SUMMARY

(1) The literature describing cases of snapping thumbs due to involvement of the flexor pollicis longus tendons has been reviewed.

(2) A case of bilateral snapping thumbs has been reported.

(3) These cases do not respond to conservative treatment and should be treated surgically.

BIBLIOGRAPHY

- ¹ De Quervain, F.: Über eine Form von chronischer Tendovaginitis. Cor.-Bl. f. schweiz. Aerzte, vol. xxv, p. 389, 1895.
- ² Finkelstein, H.: Stenosing Tendovaginitis at the Radial Styloid Process. Jour. Bone and Joint Surg., vol. xii, p. 509, July, 1930.
- ³ Poulsen, K.: Doigt á ressort. Bibliot. f. Laeger, p. 55, 1908; Tenosynitis i förste Kuliss paa antibrachium. Hospitalstidende, p. 66, 1911; Sehnenscheidenentzündung im ersten Fach des Antibrachium begleitet von Traktionsperiostitis am Processus styloideus radii. Deutsch. med. Wchnschr., vol. xxxvii, p. 843, 1911.
- ⁴ Nussbaum, A.: Beitrag zur Tendovaginitis stenosans fibrosa des Daumens (de Quervain). Bruns' Beitr. z. klin. Chir., vol. civ, p. 140, 1917.
- ⁵ Troell, A.: On Tendovaginitis and Tendinitis Stenosans. Acta chir. Scandin., vol. liv, p. 7, 1921-1922.
- ⁶ Hauck, G.: Über eine Tendovaginitis stenosans der Beugeschnenscheide mit dem Phänomen des schnellenden Fingers. Archiv. f. klin. Chir., vol. cxxiii, p. 233, 1923.
- ⁷ Kroh, F.: Schnellender Finger und stenosierende Tendovaginitis der Finger beugeschne. Archiv. f. klin. Chir., vol. cxxxvi, p. 240, 1925.

TRANSACTIONS

OF THE

NEW YORK SURGICAL SOCIETY

STATED MEETING HELD NOVEMBER 9, 1932

The President, DR. JOHN DOUGLAS, in the Chair

SYMPATHECTOMY FOR HIRSCHSPRUNG'S DISEASE

DR. EDWARD J. DONOVAN presented a man, twenty-three years of age, who was first admitted to Saint Luke's Hospital May 2, 1921, at the age of twelve years, complaining of constipation since birth. His past history, aside from the chief complaint, was negative except for the fact that he had passed a small amount of blood by rectum one year before. X-rays at this admission showed a very large descending colon. In spite of the fact that no anal obstruction was found, the diagnosis of acquired, rather than congenital, megacolon was made. He was discharged from the hospital with his bowels moving daily as the result of cascara and milk of magnesia.

He was readmitted one year later with fecal impaction, and with the history that the above-mentioned régime was successful for only two months after leaving the hospital. Constipation became so bad that he often had but one bowel movement a week. Daily colon irrigations and cathartics removed the impaction. X-rays at this time showed a very great dilatation of the descending colon, sigmoid and rectum.

He was then operated upon by Doctor Bolling July 24, 1922, at which time descending colon, sigmoid and rectum were found greatly dilated. Forty-eight centimetres of sigmoid were then removed, and lateral anastomosis done between descending colon and rectum. Convalescence was uneventful, and he was discharged to the country on the eighteenth post-operative day.

He was admitted three years later with fecal impaction, stating that operation had given relief for about two years. For past year constipation has returned and now is as bad as before. X-rays at this time show prodigious dilatation of lower colon.

Readmitted with fecal impaction January 15, 1932, with history that the rectum feels full all of the time, and that he has no expulsive force in the rectum to empty it. Thinks that he has lost twenty-five pounds in the past few months. Advised at this time to have a sympathectomy, nearly ten years after resection of intestine. He was given an anæsthetic and the fecal impaction was removed manually.

He returned to the hospital February 2, 1932, for the sympathectomy. In preparation for this, he was kept in bed for one week on a low residue diet with a colon irrigation twice a day. February 9, 1932, pre-sacral nerve and part of two inferior mesenteric nerves were removed by transperitoneal

HIRSCHSPRUNG'S DISEASE

approach. The descending colon and sigmoid were so large that they had to be mobilized to remove them from the site of the operation. Also a lateral anastomosis had been done between the descending colon and rectum. This fact could not be determined by examination of the anastomosed structures at this time. Peritoneum over the sacrum was incised in the mid-line, and the pre-sacral nerve located just beneath this incision in the region of the left common iliac vein. It was cut below the brim of the pelvis just above the hypogastric ganglia and dissected upward, cutting the branches from the fourth, third, second sympathetic ganglia until the inferior mesenteric nerves, found one on either side of the inferior mesenteric artery, were reached. One inch of each inferior mesenteric nerve was resected with the pre-sacral nerve. The patient's convalescence was most uneventful. On the third day after operation the first enema was given. This was expelled with great force and was accompanied by a very satisfactory bowel movement. (Remember that he complained of a lack of expulsive force in the rectum.) Enema daily and mineral oil caused a satisfactory bowel movement each day for the twelve days that he remained in bed. The thirteenth day, or the first day that he sat out of bed, his bowels moved without an enema. He has had no bladder disturbances at any time.

HIRSCHSPRUNG'S DISEASE

DR. EDWARD W. PETERSON, remarked that Hirschsprung, in 1886, described the disease which has since borne his name as "a condition of congenital high-grade dilatation of the colon, with thickening of all its tunics, especially the tunica muscularis, and retention of large quantities of fecal matter." The dilatation and hypertrophy may affect a part of or the whole of the large bowel. To the cardinal symptoms—dilatation of the colon, abdominal distention and obstipation—may be added languor, apathy, loss of weight, anæmia and general muscular weakness. Occasionally there may be abdominal discomfort, vomiting, fever and evidences of auto-intoxication. Usually when diarrhœa occurs it is merely the over-flow of fecal retention.

The treatment of idiopathic dilatation of the colon in the past, by both medical and surgical measures, had, for the most part, proved unsatisfactory. Following the work of Hunter and Royle, of Sydney, Australia, Wade and Royle, in 1927, reported a case of Hirschsprung's disease treated by ramisection of the lumbar sympathetic ganglia, with excellent results. Later Judd, Adson, Rankin, Learmouth, of The Mayo Clinic, Wade and others had given encouraging accounts of their experience with this operation. There were no deaths recorded. All cases, it seems, were benefited, and the end-results, in properly selected cases, were "spectacular." He himself could add three cases to the growing list of satisfactory results following sympathetic neurectomy.

CASE I.—A boy, fourteen years of age, had shown obstipation since birth. Frequent purgatives, enemata and irrigations were always required to move the bowels. The boy never had a natural bowel evacuation. The abdomen

was distended and pendulous and the colon was greatly dilated. In July, 1931, he was admitted to the Babies' Wards of the Post-Graduate Hospital for observation and study. While there he developed acute intestinal obstruction. Dr. R. F. Carter saw him then in consultation, and performed an emergency cecostomy, and introduced a Paul's tube. Rectal and irriga-

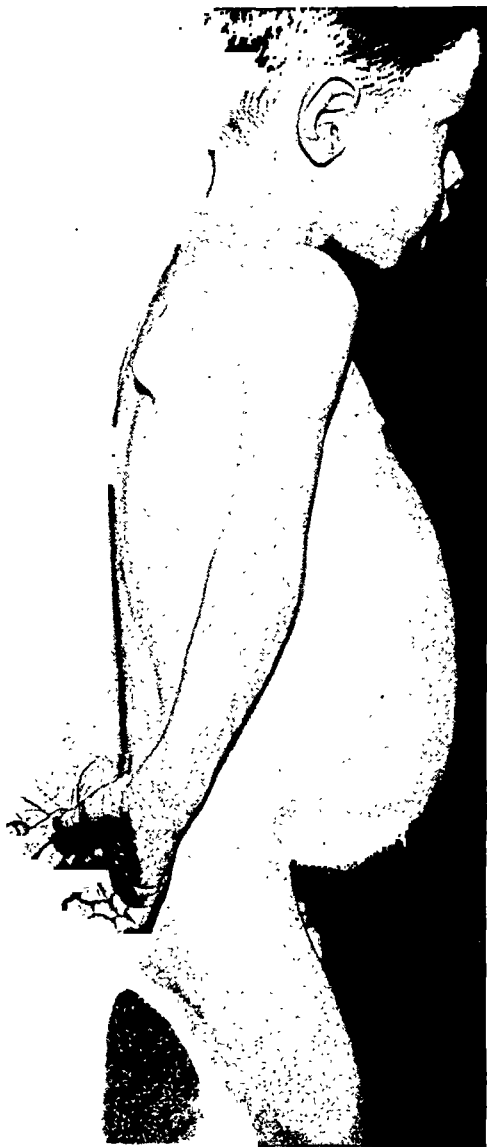


FIG. 1.—(Case II.) Hirschsprung's Disease. Distention two days before operation, after weeks of attempts to reduce the size of the abdomen.

tions through the cecostomy opening relieved the obstruction, but had to be continued daily to empty the colon. This treatment was carried out for a long period following the operation and caused considerable decompression of the greatly distended abdomen, but the obstipation persisted. January 14, 1932, the abdomen was opened and the whole colon, and even the appendix, found dilated. The pre-sacral, inferior mesenteric nerves and left lumbar ganglia were resected. Following operation, mineral oil, cascara and irrigations were given as a daily routine. Spontaneous bowel movements began February 2, 1932. At present the patient has one or two normal stools a day without any medication, abdominal distention is no longer present, his general health is excellent, and his whole outlook on life has improved.

CASE II.—A boy, four years and eight months of age, was admitted to the Babies' Wards of the Post-Graduate Hospital, August 20, 1932, with a history of constipation during infancy, requiring the frequent administration of cathartic drugs for its relief. After the first year of life normal bowel evacuation rarely occurred, and cathartics and enemata

were always necessary to empty the colon. Abdominal distention and colon dilation gradually became more and more marked. (Fig. 1.) Loss of appetite, abdominal discomfort, slight fever and occasional vomiting would always follow if laxatives and enemata were neglected. A röntgenogram, taken September 14, 1932, showed marked dilatation of the whole colon. Preliminary treatment, aimed at decompression of the abdomen, was given for several weeks

HIRSCHSPRUNG'S DISEASE

before operation. The distention was reduced considerably, but in spite of active mineral oil, cascara and colon irrigation treatment, the obstipation persisted. September 16, 1932, the pre-sacral and inferior mesenteric nerves were resected. Convalescence was very satisfactory. A stool was passed spontaneously on the ninth post-operative day, since which time one or two movements a day have occurred. There has been a marked improvement in the general health of the boy, but the abdomen, while greatly improved, is still larger than normal.

CASE III.—A boy, four years and eight months of age, was admitted to the Babies' Wards of the Post-Graduate Hospital, September 21, 1932, with a history of constipation since birth. He had had very few, natural bowel movements during his life, and would go for days without a stool, unless laxatives or enemata were given. Of late the obstipation had become much more troublesome. Some abdominal distention, but not marked. A röntgenogram, taken October 16, 1932, showed dilatation of the rectum and sigmoid. October 18, 1932, a laparotomy was performed and the pre-sacral, inferior mesenteric nerves, and the left lumbar ganglia were resected. On the third day after operation there were three spontaneous bowel evacuations, since which time the bowels have continued to act naturally. Aside from an upper respiratory infection, convalescence has been most satisfactory.

It is now ten months since sympathectomy in Case I. The patient has never felt so well. His bowels now move spontaneously daily without even taking mineral oil. He has gained about twenty pounds in weight.

His X-rays at the present time show a rather large colon. They also show very good emptying of the part affected by this operation.

DR. HENRY F. GRAHAM reported the case of a child recently admitted to the Brooklyn Methodist Hospital. The child was in very bad condition and an effort was made on the Pediatric Service to clean out the bowel and improve the condition generally. A transfusion was advised, to be followed later by sympathectomy. The child, however, died before anything could be done. At autopsy the findings were a large dilated sigmoid and rectum which terminated sharply below at a spastic hypertrophied sphincter. A microscopical examination of the hypertrophied portion showed merely normal muscle tissue.

DR. CHARLES L. JANSSEN said that one should keep in mind that not all results are as gratifying as the ones presented. He recently had the opportunity to observe a case in a girl of twenty-four years. After lumbar sympathectomy performed by one of the leading surgeons of this city, the symptoms became considerably more severe, so much so that the digital extraction of fæces was the only way an evacuation could be obtained. However, under conservative treatment there has been marked improvement. In this case the lower extremity of the operated side showed an increase of surface temperature. The maximum difference recorded by the thermo-couple

was 7°. This inequality of temperature was a source of real discomfort to the patient.

Doctor Donovan said that he was disappointed in the last X-ray of his patient to find that there was no evident decrease in the size of the colon. In spite of this fact the patient had a splendid functional result. Doctor Peterson had told him, however, that in his cases where he had resected the ganglia as well as the pre-sacral and inferior mesenteric nerves that there was little evident decrease in the size of the colon.

The speaker had been surprised to find what a simple matter it was to resect the pre-sacral in his case. Some of the recent articles on the anatomy of this nerve show that this varies a great deal but in this case it was a single cord. Regarding bladder disturbances after resection of the pre-sacral nerve, some cases have been reported that had frequency and urgency but of very short duration.

DOCTOR PETERSON added that at present, one did not know how much or how little to do, in resecting the lumbar sympathetic nerves, in Hirschsprung's disease. Wade advocated, through a long incision in the flank, an extra-peritoneal division of the mesially directed branches and the main chain itself below the fourth lumbar ganglion. Judd and Adson have advised, through a transperitoneal operation, the resection of the second, third and fourth lumbar ganglia on both sides. Rankin and Learmouth believe that resection of the pre-sacral and the inferior mesenteric branches will sever all the nerves to the parts of the bowel chiefly affected, thus avoiding the minor disadvantage of disturbing the neurovascular supply of the lower extremities.

Doctor Peterson felt inclined, from his very limited experience, to advocate the resection of the pre-sacral and inferior mesenteric nerves, and also to remove the sympathetic ganglia on the left side.

BIBLIOGRAPHY

Royle: Med. Jour. of Australia, vol. i, p. 77, 1924.

Hunter: *Ibid.*, p. 86.

Wade, and Royle: Med. Jour. of Australia, vol. i, p. 137, 1927.

Judd, and Adson: ANNALS OF SURGERY, vol. xxviii, p. 479, 1928.

Scott, and Morton: Jour. of Clinical Investigation, vol. ix, p. 247, 1930.

Rankin, and Learmouth: ANNALS OF SURGERY, vol. xcii, p. 710, 1930.

Wade: The Lancet, vol. i, p. 136, 1930.

Rankin: Am. Jour. Surg., vol. xv, No. 2, p. 219, 1932.

Mayo, Charles: ANNALS OF SURGERY, vol. xcvi, p. 486, 1932.

ADENO-CARCINOMA IN A CYST OF THE TRANSVERSE MESOCOLON

DR. EDWARD W. PETERSON presented a woman, sixty-four years of age, who was admitted to the Post-Graduate Hospital, September 19, 1932, complaining of attacks of nausea, vomiting and diarrhoea, and the presence of a movable tumor in the upper abdomen. Twenty years ago she was treated for gastric ulcer and was confined to her bed for six weeks at that time. A gastro-intestinal X-ray study was made thirteen years ago in a Brooklyn hospital. She was told that she had no ulcer but that a chronic appendicitis was responsible for her gastro-intestinal upsets. One and one-half years ago

TORSION OF THE OMENTUM

a tumor, just above and to the left of the umbilicus, was discovered. The tumor gradually grew larger and was about the size of a small grape-fruit when she was admitted to the hospital. This growth appeared to be cystic, was movable in all directions, and pressure upon it caused slight nausea and discomfort. Patient weighed but eighty-five pounds, having lost about fifteen pounds in weight during the past year.

Wassermann, blood-chemistry, and urine negative. Blood count showed only a slight degree of anæmia.

Operation.—September 22, 1932, under spinal anæsthesia, the abdomen was opened through a left rectus incision over the tumor mass. The growth was situated in the mesentery of the transverse colon, was filled with dark fluid superficially, and broken-down, soft material in the depths of its cavity. Some of this material was sent to the laboratory and the report came back that it was "papillary adeno-carcinoma, of a highly malignant nature." It was impossible to remove the tumor without resecting the colon, so marsupialization and gauze packing of the cavity were carried out. The poor condition of the patient did not warrant any more radical procedure.

No other focus of malignancy was found in the abdomen or elsewhere. Doctor Meeker, who made the pathological study in this case, stated that the growth could have been of ovarian origin or possibly could have arisen from sequestered intestinal tissue in the mesentery. A definite opinion, however, could not be given from the material examined as to the origin of the mesenteric cyst.

In ANNALS OF SURGERY, September, 1932, five cases of mesenteric and one case of omental cyst were reported by the speaker. It is desired to add another case to this relatively rare group of abdominal cysts.

DR. CHARLES E. FARR remarked that mesenteric cysts apparently are either false or true in type. The false cysts may be caused by trauma, by infection, or by invasion with echinococcus. True cysts may take their origin in congenital anomalies, or they may be due to cystic changes in the normal structures in the mesentery or to accidental implantations from surrounding structures, or they may result from the closing of intestinal diverticula.

The diagnosis of mesenteric cyst is rarely properly made before operation.

The diagnostic feature of the mesenteric cyst is a freely movable tumor, evidently intra-peritoneal or retro-peritoneal and of a cystic feel. The use of a contrast meal and pneumoperitoneum would be of great assistance. However, it is difficult, if not impossible, to rule out the soft, cystic feeling but really solid sarcomata.

The treatment of mesenteric cysts is preferably by excision. This is not always feasible, however, and proper treatment may require excision with resection of bowel—a much more formidable operation. Marsupialization should be used as a last resort only, but it is occasionally necessary and the results are at times quite satisfactory. In malignant cysts wide excision is theoretically the ideal but as in Doctor Peterson's case it may not be practicable.

TORSION OF THE OMENTUM

DR. CHARLES E. FARR read a paper with the above title for which see page 766.

DR. FRANK S. MATHEWS recalled one case of irreducible omental hernia in which acute symptoms developed and at operation there was found a mass of omentum in the scrotal sac which was adherent and not rotated. On making traction upon it a large mass of rotated omentum was found just within the abdominal cavity.

Rotation of the omentum is a particular under the general subject of visceral rotation, the cause of which has always seemed obscure. It is not difficult to understand the very beginning of rotation; but the difficulty seems to be to visualize any kind of mechanism which can continue to exert a rotating influence to the degree of two or three complete revolutions. The commonest structures to rotate are the ovarian tumors, which in themselves have considerable weight and a small pedicle. The testis also at times rotates, but nearly always it is a partially descended testis with a looser attachment than normal.

Two of the most vivid recollections of visceral torsion have been: First, a case of volvulus in a case of megacolon, the abdomen distending to an enormous size in the course of a few hours. The second was a case of volvulus of the small bowel secondary to a Meckel's diverticulum. In this case a profound shock developed in a few hours from the beginning of the symptoms. At operation the abdomen contained much blood-stained fluid; the Meckel's diverticulum was rotated, swollen and plum-colored and about two feet of adjacent ileum were rotated. Here appearances would indicate that the diverticulum first rotated and then acted as a rotator of the bowel. But just how the diverticulum with an attachment only to the bowel could twist it is difficult to see.

Doctor Mathews once assisted Dr. Charles N. Dowd to operate on an acute volvulus of the caput coli in a young man. When it was reduced its attachment proved to be unusually lax. The appendix almost never rotates. Among the less frequent varieties one might mention an axial rotation of an ovary and Fallopian tube in a child. The tube was the seat of a previous pathological process, the end being closed and possibly the seat of a tuberculosis. Dr. William Berry has reported a rotation of a gall-bladder which was not the seat of stones or other previous pathology, but was attached by an unusually long mesentery.

Bland Sutton, in his "Diseases of the Ovary and Fallopian Tube," gives a chapter to axial rotation and mentions two conditions which predispose ovarian tumors to rotation. These are first bilateral tumors, and second ovarian tumor and pregnancy. The termination of the pregnancy in these cases is especially prone to lead to a rotation of the tumor. Fibroids seem to rotate infrequently considering the number of pedunculated ones which are seen. Probably this depends on the rigidity of their attachment.

Doctor Mathews once operated on a case of volvulus shortly after a confinement. There was a fibrous band from the uterus to the side of the pelvis. The small bowel had very largely passed under this band. When the band was divided it was found that the bowel with the root of the

mesentery had rotated through nearly a complete circumference in passing under the band.

DR. JOHN H. GARLOCK stated that he had seen three cases of torsion of the great omentum at the New York Hospital during the past few years. All three simulated acute appendicitis and were diagnosed as such before operation. Two of them he had operated upon personally, and the third was operated upon by Dr. Frank J. McGowan. In two instances the torsion was of the free variety; that is, without any attachment peripherally. In the third case, the distal end of the twisted omentum was attached to an inflamed ovary. Judging from this experience and from the cases presented tonight, one would say that the free variety of torsion of the great omentum was more common than that type in which the distal end of the omentum is attached to some abdominal organ or hernial sac.

DR. FRANK B. BERRY said his impression was that the torsion is more common where there is an attachment. He had seen one case in a boy fourteen years of age in which the omentum was free and quite thin. The peritoneal cavity contained considerable bloody fluid plus a mass of omentum which had rotated on itself. He has often wondered whether an incarcerated hernia suddenly giving symptoms of strangulation may not be due in part to partial torsion of the omentum.

DR. PERCY KLINGENSTEIN, speaking of Doctor Farr's reference to other forms of omental torsion, called attention to torsion of the appendices epiploicæ which can occur intra-abdominally or in a hernia. Particularly is this more common in femoral herniæ. These appendices may undergo complete necrosis and calcification, become detached and appear as loose free bodies (*corpora aliena*) in the peritoneal cavity.

DR. JOHN H. MORRIS remarked that the etiology is the most interesting phase of this condition and in this respect one must consider the bearing of the individual and the physical development. For example, at one time he had four patients, all males, all weighing about 200 pounds, all with full abdomens and considerable subcutaneous fat and diffusely infiltrated omenta. Many theories have been advanced, but the speaker thought the evident infiltration by fat of the omentum and their conformity to a definite stature may be significant. As to the classification Doctor Morris considered that one can divide them into those associated with hernia and those of intra-abdominal origin which were either related to associated pathology or were idiopathic in origin. There is another side to be considered in these days of workmen's compensation. He cited a case of a man riding in a motor truck over a rough road, suddenly seized with severe abdominal pain, put in a hospital, observed for two or three days, operated on and a gangrenous omentum found. He died of peritonitis. The medico-legal question came up as to whether the trauma induced was sufficient to cause torsion of the omentum and, if so, was this a compensable injury.

TRANSACTIONS

OF THE

PHILADELPHIA ACADEMY OF SURGERY

STATED MEETING HELD OCTOBER 3, 1932

The President, DR. JOHN SPEESE, in the Chair,

CALVIN M. SMYTH, JR. M.D., Recorder

AN EVALUATION OF THE TANNIC-ACID TREATMENT OF BURNS

DR. JAMES B. MASON, by invitation, read a paper with the above title for which see page 641.

DR. ISADOR S. RAVDIN said that some years ago Doctor Ferguson and himself wrote several papers advocating adrenalin and novocaine dressings in the treatment of burns, but the tannic-acid method has supplanted every other used at the University Hospital.

DR. GEORGE M. DORRANCE said that he is called upon to treat a large number of burn cases at Saint Agnes' Hospital. The reduction of the mortality especially interested him. The general care of the patient is an important factor in this respect. Transfusions are of great value. For dressings he uses $\frac{1}{2}$ per cent. acetic acid. Where there is a definite area of slough, lattice-like slits are made through it and the area covered with acetic acid and it is surprising to see how quickly the slough disappears. The débridement treatment in his experience is too severe. The death rate is higher from burns than from appendicitis. He considers burn cases as emergencies and sees them immediately. If the patient is seriously burned, a blood count is ordered and if the leucocytes are 50,000 or over, a fatal outcome is inevitable. It is a common occurrence to find the hæmoglobin to be 110 and the erythrocytes 6,000,000 in these cases.

DR. WALTER ESTELL LEE said that tannic acid possessed one advantage over any other method in the treatment of burns to which Doctor Mason has only indirectly referred, namely, the relation of the final scar tissue to the type and duration of the infection of the granulating surface of the wound. The amount of scar tissue which follows burns treated with tannic acid is almost nil because of the short period of suppuration. From a long experience with burns he had been convinced that the scar tissue which follows the usual treatment of burns with unsterile dressings and medications is largely (estimate 80 per cent.) due to replacement of tissue lost by the suppuration and that tissue destroyed by the burn itself plays a minor rôle in the formation of this scar tissue. Since the use of tannic-acid treatment scar tissue in their wounds has been almost negligible, and it is a rare

PERFORATION OF DUODENAL DIVERTICULUM

exception to find it necessary to graft the surfaces with skin. It cannot be too frequently emphasized and restated that burns treated with tannic acid show less infection and suppuration and scar tissue than with any other treatment.

USE OF CONTINUOUS INTRAVENOUS INFUSIONS IN ACUTE ABDOMINAL INFECTIONS

DR. ISADOR S. RAVDIN and (by invitation) DR. CHARLES JOHNSTON read a paper with the above title for which see page 749.

DR. FRANK MOGAVERO (by invitation) remarked that in Doctor Muller's service at the Misericordia Hospital, extensive use was made of continuous intravenous infusion. In their experience the needle is unsatisfactory on account of the tendency for it to slip out of the vein and for this reason the canula was employed. The apparatus which they use, the speaker does not believe is as complicated as that described by Doctor Ravdin. It consists only of an ordinary Kelly bottle with a Murphy drip regulator interposed between the bottle and the canula. The rate of flow is controlled by a screw clamp which is placed above the drip regulator. This simple form of apparatus has given great satisfaction and requires the minimum amount of nursing care.

DR. ISADOR S. RAVDIN said that Dr. George Muller and himself used a method similar to that referred to by Doctor Mogavero a number of years ago. In their experience it was not as satisfactory as the method described. The side holes in the Murphy bulb must be closed. The method which he now uses is not complicated and, furthermore, it does not necessitate an additional flask for the introduction of the fluid, since the Erlenmeyer flask in which the solution has been sterilized can be used. Some trouble was formerly encountered with the needle slipping out of the vein, but since using the adhesive straps for retention and fixing the arm in a pillow, this rarely occurs. However, it is not the method so much as an appreciation of the problem of fluid and salt requirements which is essential.

PERFORATION OF DUODENAL DIVERTICULUM

DR. J. WALTER LEVERING (by invitation) reported the case of a man eighty years of age who was seized with severe abdominal pain causing him to collapse. He was immediately brought to the Abington Hospital. He gave a previous history of indigestion for many years with epigastric pain about one hour after meals which was relieved by taking food or soda. There was nothing else in the history of importance. He was apparently in extreme shock; cyanotic and dyspnoëic; cold, clammy skin. The heart was enlarged to the left and the sounds were weak. The abdomen was tender and rigid, the rigidity being board-like and general. No peristalsis was heard. No masses were felt. There was no dullness in flanks. A diagnosis of perforated duodenal ulcer was made.

At operation a small perforation of the duodenum was located, the perforation being just beyond the pyloric sphincter. Duodenal contents were leaking out. The first portion of the duodenum seemed to bulge for-

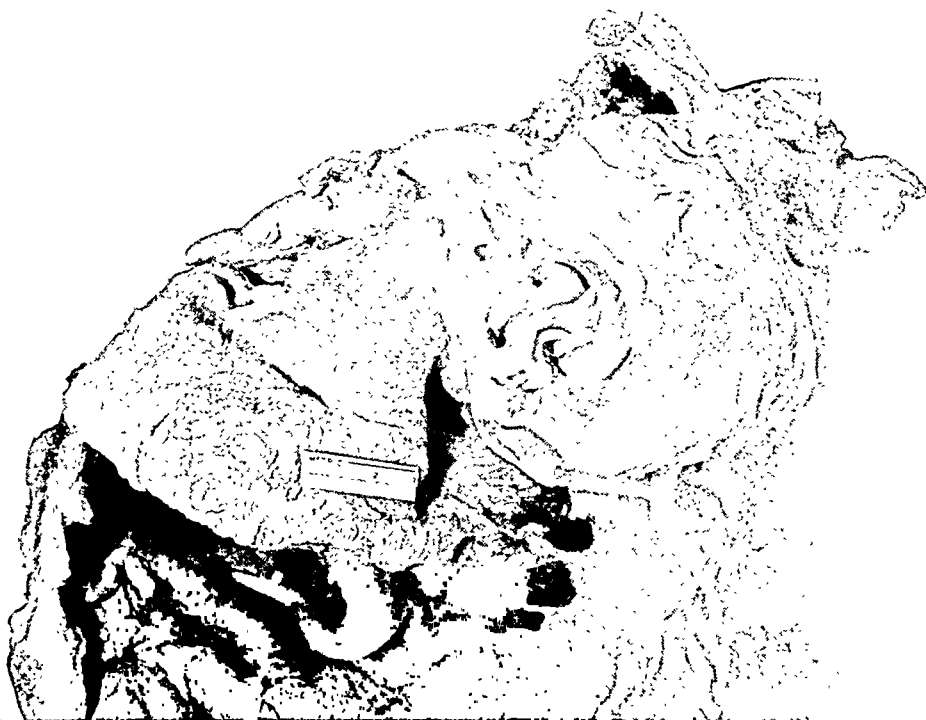


FIG. 1.—The site of the perforation is marked with a probe.



FIG. 2.—Interior of duodenum, showing multiple diverticula.

PERFORATION OF DUODENAL DIVERTICULUM

ward. The liver and gall-bladder appeared normal. The pancreas and appendix were not visualized. The perforation was repaired with purse-string and mattress sutures and a piece of omentum sewed over it. A jejunostomy was done in the usual manner. A suprapubic puncture was made and a cellophane cigarette drain inserted.

Except for a weak irregular pulse the patient's first three post-operative days were normal. Blood chemistry was normal. On the fourth day, he vomited some greenish material and a Jutte tube was inserted. Glucose was given intravenously daily. Peristalsis was present from the fourth day and enema were effective. The pulse, however, continued poor and on the eighth day after operation he died, having vomited blood some hours previous.

Autopsy Findings.—*Lungs.*—Œdema, emphysema. *Heart.*—Calcareous infiltration of the mitral orifice leading to regurgitation. Chronic aortic valvulitis, fibrosis of the myocardium and fatty degeneration. *Abdomen.*—Localized peritonitis under lobe of liver. Multiple diverticuli of the duodenum, one of which has a necrotic base with a pin-point perforation which has been walled off. (Figs. 1 and 2.) Acute dilatation of the stomach. Chronic glomerular nephritis. Interstitial splenitis. Moderate arteriosclerosis.

The speaker remarked that in the literature, one is impressed first with the antiquity and later with the frequency of this condition. The first period, as Lockart suggests, the "mortuary" period of 200 years, dates from 1710 to 1910. During this period, less than 100 cases were described at autopsy. Morgagni knew of the existence and mentions a case in 1711. One would expect this reference of Morgagni to be the first, but Chomel, of the Academy of Paris, in 1710, gave an account of a woman, aged eighty, who had a pouch or pocket in her duodenum with stones found at autopsy. For two years previous to her death she had complained of pain and gas two hours after eating.

The second period, known as the period of "röntgenology," from 1910 on, abounds with reports of cases diagnosed by the X-ray, some confirmed at operation and others at autopsy. Therefore incidence is frequent. Regarding position, it has been found in all three portions of the duodenum, usually the second projecting from the median surface. The diverticula may be multiple or single, as high as six are reported.

It is more often found in the relatively old. The size of the sac may vary from very small to three to four centimetres deep and one to two centimetres wide. They consist of mucous membrane and connective tissue, and are devoid of a muscular layer. Except in complications they are devoid of signs of inflammation. Other writers claim that they have a complete muscular coat.

Symptoms are probably due to complications. While they may give symptoms it is practically impossible to diagnose them without the X-ray, as the symptoms are usually similar to those of inflammation of the other anatomically adjacent viscera as in inflammation of the stomach, duodenum, gall-bladder or pancreas.

Lucinian reports a diverticulum perforated into the pancreas. His patient, a woman, thirty-eight years of age, had been operated upon two years previously for

gall-bladder disease. A gall-bladder full of stones had been removed but her symptoms of indigestion, pain after eating, and gas, showed no improvement for two years, after which she was X-rayed and the diagnosis made of duodenal diverticulum perforating into pancreas. This was confirmed by operation. Operation cured her of her symptoms.

Gask (St. Bartholomew's Hospital Report, vol. lxii, 1929) advises against operation in these cases merely because they may be picked up in the X-ray and believes the large majority give no trouble. He tells of a case that was operated upon and no inflammation found. Two years later, because of a continuance of symptoms, upon reoperation an ulcer on the lesser curvature was found, which he felt was overlooked at the time of the first operation.

There are many complications but only a few are reported with serious result. Prolonged retention of material in the sacs favors diverticulitis. Inflammation favors ulceration. Ulceration favors perforation.

Monsarrat in the *British Journal of Surgery*, 1926, reports an acute perforation in a woman, aged fifty-eight, with recovery following operation. Bauer (Geneva, 1912), reports a fatal obstruction.

The speaker remarked that perhaps the most interesting phase of this subject discussed in this literature is the etiology. Most of the writers conclude that the cause is congenital. The studies of Falcomer and Tandler all support the view that duodenal diverticula are congenital in nature, representing abortive attempts at the formation of a supernumerary pancreas. Linswanger holds that they are congenital only in the sense that these pancreatic anlage cause local defects in musculature. Lockart gives the following reasons for attributing diverticula to congenital defects: (1) The condition has been found in infants. (2) It may be multiple. (3) It may be associated with similar changes in other parts of the alimentary tract. Otto Hahn, in a very complete review of the literature of duodenal diverticula (1931), quotes exhaustively the different writers with their congenital arguments, but, nevertheless, groups the "divertikel" later into headings such as: *Das Papillen divertikel*; *das Ulcers divertikel*; *das Traktions divertikel*; *das gallenstein*; *das sogenante kingenitali*; *das stenosen divertikel an der flexur duodeno-jejunal*—thus concluding that some are congenital, some acquired. Odgers, of the University of Oxford, suggests calling them primary when there is no obvious cause for their appearance. This includes congenital; secondary when there is some cause, such as ulcer, adhesions, or stricture.

CONGENITAL DUODENAL ADHESIONS

DR. HARRY E. KNOX remarked that adhesions were spoken of by Neff and Haden in the *American Journal of Diseases of Children* in 1925 as "Transduodenal Adhesion of Congenital Origin," when they reported the autopsy findings in three infants who died of vomiting from unknown cause. Again, Higgins and Patterson, of England, in the *Archives of Diseases of Childhood*, in 1926, reported a like condition which they described as "Congenital Duodenal Stenosis Due to Peritoneal Bands." In February, 1931, the speaker reported to the Philadelphia Pediatric Society a series of six cases which he designated as "Congenital Duodenal Adhesions." Since then Dr. Ralph M. Tyson, of Philadelphia, reported four cases. Dr. W. Estell Lee, of this Academy, in a personal communication, recorded another case and to these already reported Doctor Knox now adds the following two:

CASE I.—Male, white, eight days old, with a history of having vomited from birth. A diagnosis of pyloric stenosis was made and operation performed on the fifth day of life. Vomiting continued, was bile stained, and the infant continued to lose weight and became extremely dehydrated. Seen

CONGENITAL DUODENAL ADHESIONS

in consultation three days after operation a diagnosis of congenital adhesions was made and a second operation was performed on the eighth day. No difficulties were encountered and after exposing the duodenum many dense adhesions were found and separated. The immediate post-operative condition of the infant was far beyond expectation. Vomiting ceased, the child began to have green stools and a slight gain in weight occurred. However, œdema of the lower extremities developed, the urine showed red blood-cells, and the child died six days after the second operation from acute nephritis, a condition which is frequently seen after operations upon the very young. Autopsy was refused.

CASE II.—White, male, eighteen days old, weight five pounds and fourteen ounces, with a history of vomiting since birth, and jaundice; marked dehydration, sunken fontanelles; chest and heart negative. Liver and spleen not palpable. There were slight gastric peristaltic waves, but not the typical golf ball type, but more of a general gastric wave. There was a temperature range of 99° to 100° . When seen in consultation congenital adhesions were strongly suspected and operation advised. Operation was performed on the eighteenth day, after pre-operative preparations of three hypodermoclyses under ether anæsthesia. An upper right rectus incision was employed. Upon opening the peritoneum, a rather thick purulent fluid escaped. The duodenum was identified and numerous adhesions extending from the under surface of the liver to the duodenum were found. These were separated by blunt dissection. All hæmorrhage was carefully controlled. A half-inch incision was made suprapubically and a small rubber tube drain inserted into the pelvis. Wounds were closed. The patient left the operating room in fairly good condition. The next morning it was discovered that a loop of small bowel had escaped around the rubber tube drainage; this was replaced. After this the child appeared to improve greatly, vomiting ceased, the temperature reached normal for the first time since birth, and the infant began to have green stools. But this improvement was short lived, as vomiting recurred, dehydration became marked and the child died eight days after operation. The incision was reopened after death and a small fecal fistula found in the loop of bowel which had herniated. The subhepatic fossa showed the adhesions had reformed, but the purulent peritonitis recovered from.

This second case presents evidence which tends to support the speaker's theory that the cause of the adhesions may be the result of infection which originates from intra-utérine sources, traveling through or along the umbilical vessels or portal vein to the subhepatic fossa. In reviewing the symptoms that have been outstanding, and by which one may have their attention called to this most interesting and important and rather common surgical condition of early infancy, Doctor Knox mentioned the following:

(1) Vomiting. Occurs immediately after birth. In the early stages regurgitation rather than actual vomiting is the rule. Liquids are rejected almost as soon as they are taken, while as time goes on, vomiting becomes cumulative as well as projectile. Bile-stained vomitus is fairly common and bile is not seen in vomitus from a case of hypertrophic stenosis.

(2) Peristaltic waves occur, but the waves are a general gastric type at first, later becoming hour-glass in type as the gastric distension increases due to the obstruction beyond the pylorus.

(3) Loss of weight, dehydration, constipation and lessened urine output complete the picture.

(4) X-ray examination is very helpful in some cases, but when these little patients are greatly dehydrated, as most of them are, very little is gained and risk is added by the time required for the examination and the necessity for lavage afterward. If in operating upon a supposed case of hypertrophic stenosis no hypertrophy is found the subhepatic fossa should always be explored.

DR. WALTER ESTELLE LEE asked that Doctor Bromer discuss this subject from a radiological standpoint because he has probably had more experience with these lesions in infancy than any one else in Philadelphia. At the Children's Hospital a child presenting all of the symptoms of congenital hypertrophic pyloric stenosis, diagnosed as such by another radiologist, was correctly diagnosed by him. This child was nine months of age, a rather unusual period for congenital hypertrophic pyloric stenosis. The child was a Mongolian idiot and had the physical development of a baby of three months. X-ray pictures confirmed the clinical symptoms of obstruction of the pylorus. At operation there was found an enormously dilated pylorus, measuring one inch in diameter when the stomach was distended with air, and beyond this pylorus a duodenum distended to the size of a golf ball. Distal to this were adhesions of the second portion of the duodenum to the gall-bladder, liver and hepatic flexure producing the obstruction.

DR. RALPH BROMER (by invitation) demonstrated the röntgenograms of a number of cases of duodenal adhesions and discussed the interpretation of the findings.

RHEUMATIC PERITONITIS

DR. EDGAR H. WEBER (by invitation) reported the case of a boy, age seven, who was admitted to the emergency ward of the Episcopal Hospital in February, 1932, with the diagnosis of appendicitis and peritonitis. Two days previously he had returned from school feeling tired and was feverish; the boy was purged. The following day, severe abdominal pain with vomiting occurred and these persisted until admission. Except for headache, during the examination there were no other complaints. The bowels had moved several times following the laxative. He had had a definite attack of acute rheumatic fever one year previously. Otherwise, the past and family histories were irrelevant.

The throat was reddened; the heart revealed no demonstrable lesion. Abdominally, the findings were those of a lower abdominal peritonitis. There was well-marked bilateral rigidity with acute tenderness throughout the lower one-half of the abdomen. Peristalsis was faintly audible. The child was tender throughout the pelvis on rectal examination. He seemed reliably certain that sharp motion of the left ankle was painful. The temperature was 101°. The leucocyte count was 35,000.

Because of the atypical appendiceal history, the throat condition and possible significance of pain on motion of the ankle, the possibility of a systemic infection, was seriously considered. The abdominal manifestations possibly being only part of the picture, laparotomy was postponed, a decision

RHEUMATIC PERITONITIS

the wisdom of which the speaker still questions. On the following day there was an acute arthritis of the left ankle, beginning involvement of the right knee without appreciable change in the abdominal findings. On the third day the original joint improved but arthritis of both knees and the right ankle developed. In addition, the boy became semi-stuporous, very irritable and had moderate rigidity of the neck with retraction of the head and a bilateral Kernig's sign.

Large doses of salicylates were begun at this time and within twenty-four hours the meningeal and peritoneal phenomena had almost entirely abated. Joint pains subsided but a three-weeks' course of typical rheumatic fever ensued. A mitral regurgitant murmur developed on the seventh day, increased in intensity and was present on discharge three weeks subsequently.

That this boy had at the onset of his illness a peritonitis, clinically, could hardly be questioned. Doctor Weber realized the absence of essential proof in the form of operative findings and histological sections, but contended that it was a serous membrane phenomena of acute rheumatic fever, basing this contention upon the following: (1) Its occurrence in a young individual having had a previous attack of rheumatic fever. (2) The subsequent course of the illness. (3) Its spontaneous resolutions apparently hastened by the administration of salicylates. These features are in complete accord with those of other reported cases of rheumatic peritonitis.

It is unusual to have such pronounced involvement of the peritoneum at the onset of acute rheumatic fever, and quite rare to have the meninges participate in this polyserositis. This case was presented entirely as a matter of interest and without thought of encouraging its consideration in the etiology of acute peritonitis. It might possibly be considered when abdominal complications occur in the course of this acute infection.

Dr. Edgar H. Weber said that the term "rheumatic" is here used in its most limited sense, namely, pertaining to the acute infectious disease, acute rheumatic fever. Thus, rheumatic peritonitis indicates an inflammation of this serous membrane incited by the organism of acute rheumatic fever.

DR. CALVIN M. SMYTH, JR., recalled a case of a little girl six years of age, who was brought in to the Abington Hospital one night with typical history of acute appendicitis. She was operated upon a few hours after admission, at which time a comparatively normal appendix was found but the lumen was packed with round worms. Her symptoms were, therefore, thought to be due to mechanical rather than inflammatory conditions. Three days after operation she complained of pain in both hips and thereafter ran a typical three-weeks' course of rheumatic fever. Dr. Joseph Stokes, who saw her at that time, was inclined to attribute her original symptoms to the rheumatic involvement of the lymphatic tissue in the appendix or else that the appendix had nothing whatever to do with the picture.

BRIEF COMMUNICATIONS

AN INTER-RINGED CLAMP

A SPECIALLY designed ring clamp to hold and secure tissues and viscera has proved satisfactory in many diverse operations after extensive trial.

The usual ring clamp has two equally grooved rings which, when closed, fix the tissue between them in an actual bite or crush. It is required that all the grooves and bars match and set exactly, otherwise the entire clamping surface is disturbed and the instrument fails to function properly.

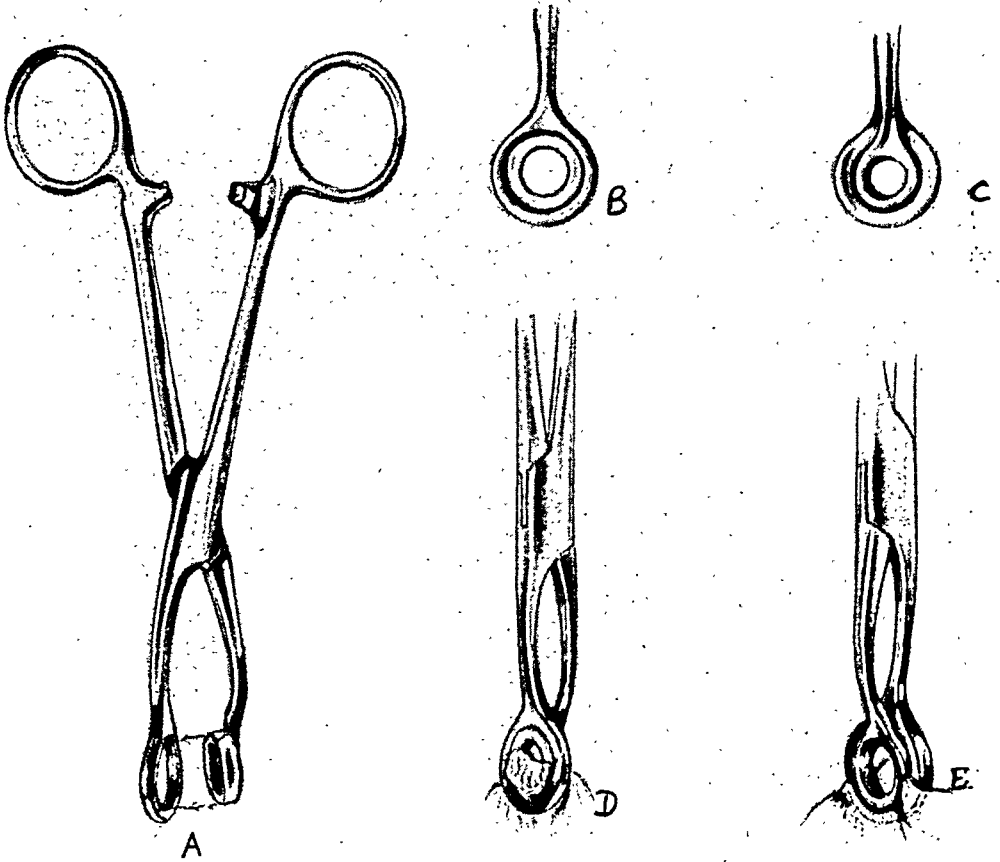


FIG. 1.—Use of the inter-ringed holding clamp in hemorrhoidectomy. A, B, C, D and E—views of the grasping parts of the instrument.

The mechanical principle involved in the type of ring clamp we have developed is not new; its non-slip quality has been employed in the Mathieu's tongue forcep, and it is commonly used in almost all catches for hose supporters.

The instrument has two rings of unequal size. The smaller ring (diameter $\frac{1}{2}$ inch) insets into the larger one (diameter $\frac{3}{4}$ inch) leaving a free space of 1 millimetre between their nearest circumferences. (Fig. 1.) It is into this free space or circular niche that the grasped tissue or viscera is firmly held

AN INTER-RINGED CLAMP

with a minimum of trauma by the opposing and counteracting rings in a grip secure and non-slipping; although without direct pressure and crush.

A clamp with unequal rings has advantages peculiarly useful for special operations. For hemorrhoidectomy, the smaller ring is applied to the skin surface of the hemorrhoid and the larger ring to mucous-membrane part of the hemorrhoid within the rectum. (Fig. 2.) This facilitates skin conserva-

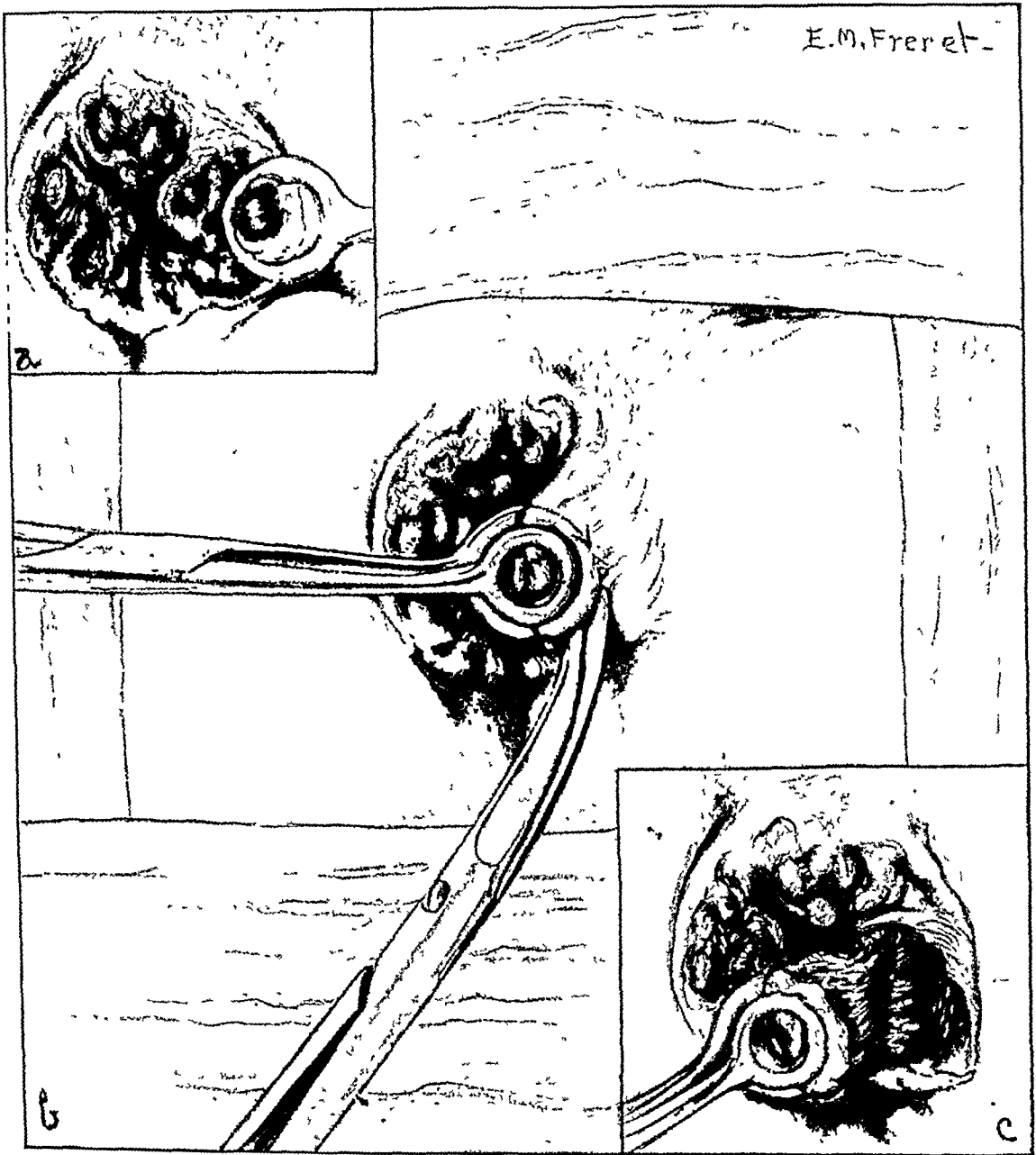


FIG. 2.—The inter-ringed clamp grasping one of the hemorrhoids. *a*.—The larger of the rings is applied to the internal or mucous membrane. *b*.—To show the smaller ring applied to a small skin surface. *c*.—The dissection of the hemorrhoid which is held firmly with this non slipping clamp.

tion and permits a large amount of slack mucous membrane of the rectal wall to be removed. Two essential requirements of the hemorrhoidal operation are thereby accomplished.

I have often demonstrated the helpfulness of this inter-ringed clamp in deep and difficult dissections of the ampulla of the gall-bladder to free it from intimate adhesions and viscera. The application of the larger ring to the

right side of the ampulla and the smaller ring to its opposite side permits a competent hold of this organ and helps to a clearer exposure of the cystic artery and the cystic duct. For this purpose I have provided the clamp with a long handle (10-inch).

For vaginal operations, necessitating flap elevations and dissection, this instrument has proved extremely useful. It is helpful and comfortable to maintain a purchase on these tissues without the annoyance of their escape by slipping or tearing during the steps of mobilization.

Cystic tumors and organs distended by fluid or gaseous contents may be grasped with comparative security by this inter-ringed clamp. The applied tension can be easily regulated by the pressure exercised through the handles and its notched catches.

WILLIAM L. WOLFSON, M.D.

Brooklyn, N. Y.

PROGRESSIVE LENTICULAR DEGENERATION

WILSON'S DISEASE

WILSON'S DISEASE, known as progressive lenticular degeneration, is a rare condition. Banti's disease likewise is of comparatively rare occurrence and has hepatico-splenic symptoms in common with Wilson's disease. Standard works of pathology and systems of surgery have neglected to cite the similarity and even mention Wilson's disease with Banti's disease.

REPORT OF A CASE.—A boy, aged fourteen, was admitted to hospital May 6, 1931, complaining of his head feeling heavy. April 12 he had had a chill with fever and remained in bed until May 1 when he noticed his feet were swollen. There were red spots on his abdomen and blood in his urine. No history of sore throat. Epistaxis since age of three years. He was of Portuguese birth; apathetic in appearance, temperature 100, pulse 100, respirations 20. *Eyes*.—Pupils react to light and accommodation. *Eye grounds*.—Negative. *Ears*.—Negative. *Throat*.—Chronic inflamed tonsils. One carious tooth. *Lungs*.—Negative. *Heart*.— $A_2 > P_2$. A soft systolic murmur transmitted to axilla. *Abdomen*.—Liver enlarged 6 centimetres below costal margin. *Spleen* felt, enlarged and tender. No varicosities. *Extremities*.—Marked œdema of both feet and ankles. Patellar reflexes, ankle clonus and Babinski test normal. No petechiæ or discolorations of skin or mucous membranes.

Laboratory Findings.—Röntgenogram of chest and heart showed no changes present. Stool negative. No typhoid organisms isolated. Widal negative. Repeated urinalysis showed heavy albumin and many red blood cells which disappeared after June 2.

On admission blood picture showed hæmoglobin 80 per cent., red blood cells 4,160,000, white blood cells 7,100 (normal differential except for 10 per cent. eosinophilia). On May 24 the eosinophilia was absent.

Discharged June 4 as suffering from acute hæmorrhagic nephritis, with possible Banti's disease.

Readmitted June 23 complaining of constant headache. Appeared sluggish and lethargic, not interested in surroundings. Temperature, pulse, and respiration normal. Liver enlarged to 8 centimetres below costal margin. The lower pole of spleen was felt at level of umbilicus. Icteric color of skin. Vandenbergh test normal, urine showed no bile but heavy albumin and many red blood cells. Œdema of legs absent. Epistaxis daily. Sinus röntgenograms normal. Blood count between July 29 and August 11 remained normal with white blood cells varying from 7,200 to 9,200. Platelets 200,000. Blood clotting and bleeding time normal. Wassermann and Kahn negative. Spinal fluid

PROGRESSIVE LENTICULAR DEGENERATION

8 millimetres mercury pressure, fluid clear and colorless. Cell count 6, globulin very slight trace. Sugar positive. Blood chemistry showed non-protein nitrogen 34 milligrams and sugar 77 milligrams per 100 cubic centimetres of blood. Blood-pressure 100/80.

July 24 subconjunctival hæmorrhages appeared. No wedge-shaped conjunctival thickening as in Gaucher's disease. Patient had a severe vomiting attack. Skin had a brownish-yellow appearance.

With the epistaxis, subconjunctival hæmorrhages, the oncoming emaciation the enlarging spleen and liver, it was decided that surgical intervention was necessary.

July 26, *pre-operative diagnosis*, Banti's disease. *Operation*, splenectomy.

The spleen was four times normal size, smooth of surface and with a few adhesions which were separated with ease from both poles. Gall-bladder thickened with pearl-gray coat and about 14 centimetres in length, greatly enlarged, but emptied easily. Liver enlarged a hand's breadth below the costal margin, surface hobnail, stony hard and suggestive of advanced portal cirrhosis. Small amount of free fluid in abdomen. *Post-operative diagnosis*, Banti's disease.

Post-operative course.—Stormy for three days and then uneventful recovery. White blood cells rose from 6,800 the day before operation to 14,600 on August 3. Discharged August 25 as improved though liver still remained enlarged.

October 21 he was readmitted to hospital after attending school for six weeks. His teacher noticed he was extremely nervous, often crying aloud in the class room. He was ataxic and his hands trembled on effort. There was hypertonicity of all muscles, the elbows were flexed, knees drawn up and the feet held in pes cavus position with toes spread out. Patellar reflex increased, no sensory disturbances, negative Romberg and Babinski tests.

There was an increasing dysphagia with loss of body weight from 98 to 65 pounds in two months. Saliva dripped from mouth, tears would stream from eyes. Violent spasms of facial muscles. The fingers were in hyperflexion, the nails burying themselves into the palmar surfaces and the hands twisted to marked ulnar abduction.

Emaciation rapidly followed and he expired February 16, ten months after onset of subjective symptoms.

Microscopical Report.—*Spleen*, weight 1,010 grams. There was a diffuse hyperplasia of the pulp with an increase of fibrous connective tissue. No evidence of Gaucher's cells could be found.

Liver.—Section showed advanced atrophic cirrhosis of the liver lobules, the entire field being replaced by fibrous connective tissue. Blood-vessels showed similar overgrowth of fibrous tissue.

Brain.—The areas of the putamen and globus pallidus were necrotic and had the appearance of a tuberculous excavation of the lung. Sections showed no normal parenchymatous tissue; increased vascularity at periphery. No giant cells could be found.

The family history showed this interesting background: *Mother*, age thirty-two. Convulsions in early childhood and again at age of sixteen. One illegitimate child before marriage. Mental age nine. Binet I.Q. 54. Is now in Territorial Hospital for the feeble-minded.

Father, age fifty-four. Heavy alcoholic. Confined to penitentiary for incest with daughter (a) at age of twelve.

Siblings.—(a) Daughter, age fifteen, in Detention Home for gonorrhœa. No nervous symptoms.

(b) Son, age twelve, in home for feeble-minded, mental age three years nine months. Binet I.Q. 44.

(c) Son, age ten, attends school. Work poor; stumbles a great deal. Marked twitching of face and hands.

(d) Patient, age fourteen, mental age eleven years. Binet I.Q. 79.

FRANCIS J. HALFORD, M.D.

Honolulu, Hawaii

THE PRINCIPLE OF THE LOOP IN BANDAGING

CERTAIN portions of the human anatomy, because of position and conformation, do not lend themselves readily to bandaging. In these locations the use of adhesive plaster may also be contraindicated because of danger of spreading infection and secondly if wet dressings are indicated adhesive tape will not usually hold the dressings in place.

Specifically we are to describe the use of this principle of bandaging to the neck, axilla and breast. We term this a principle because it has a wide range of application and if the surgeon is ingenious he can use this loop principle of bandaging in many other locations other than those to be described.

In the case of neck bandaging the surgeon is hindered by the fact that a tight bandage cannot be applied and that the usual method of bandaging leaves a loose, slipping dressing. In the case of thyroid surgery an adequate rotary bandage cannot be satisfactorily applied because of the lowness of the incision.

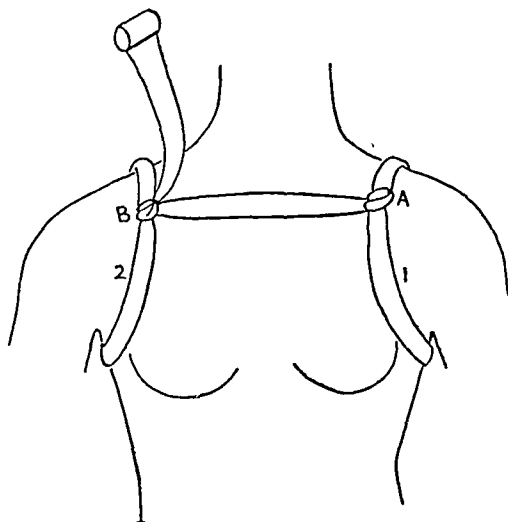


FIG. 1.

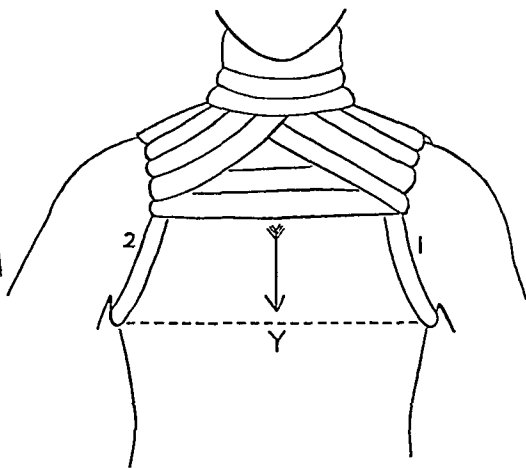


FIG. 2.

Figs. 1 and 2 show the method of application of the loop principle to neck bandaging. Using a 3-inch gauze bandage a loose loop (1) is passed over the shoulder and under the left axilla and tied at point A. The bandage is carried across the chest to point B and loop (2) placed about right axilla and shoulder and tied at point B. It is important that these loops are loosely tied. The bandage (Y) is then used to weave the bandage around neck by figure eight and cross bandaging (Fig. 2), using the loops at each reflection of the bandage to anchor the bandage. The bandaging is done equally anteriorly and posteriorly giving the result as shown in Fig. 2. Arrow (Fig. 2) shows that the bandage can be carried anteriorly if desired as far down as the nipple level and posteriorly to the middle of the scapula. The resulting dressing is fixed without being tight, is comfortable and allows free motion of arms. The dressing can be moistened without any difficulty and there is no adhesive to touch skin. The dressing in our hands has been excellent in surgery of neck, as in thyroid surgery, carbuncles, wounds of upper central portion of chest and shoulders, *etc.*

THE LOOP BANDAGE

The axilla is a most frequent site of infection and every one has experienced difficulty in securing a dressing in that location, especially when wet dressings are required. Fig. 4 shows the loop principle of bandaging as applied to the axilla. A loop of bandage is placed loosely around the neck on the side opposite to the axilla to be dressed and a knot tied at the level of the acromial spine on the side of the axilla to be dressed. The bandage is then loosely weaved back and forth as shown in diagram, using the loop for anchoring each turn of the bandage. It is important that the weaving be done to well over the point of the shoulder laterally and to the level of the sternoclavicular joint medially. At first the application of the bandage seems awkward because there is a tendency in the early weaving operation to draw the bandage too tightly and secondly because the weaving is not done uniformly. After several attempts one soon learns to apply a very handsome dressing in this fashion. The arm is given free motion, dressings cannot slip and wet dressings can

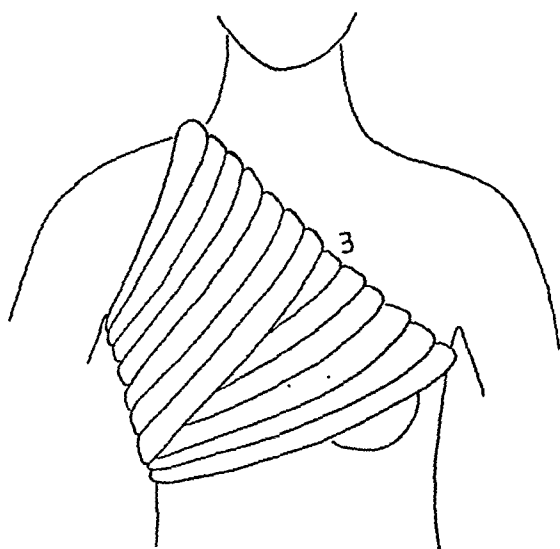


FIG. 3.

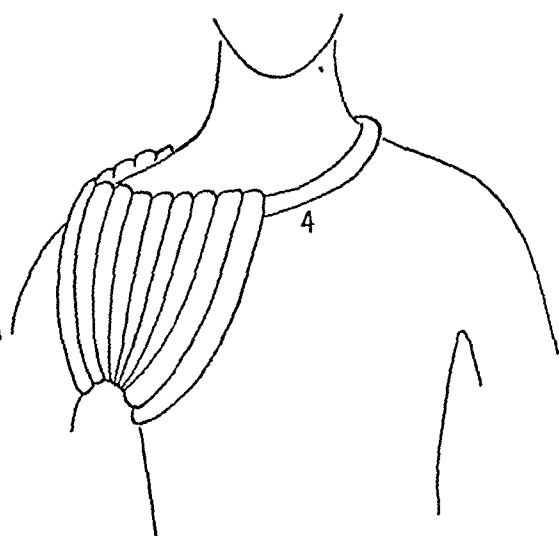


FIG. 4.

readily be maintained. Spreading of infection by tight adhesive dressings to hair follicles and adjacent tissues is eliminated.

Fig. 3 shows the application of the loop principle to breast dressings. A loop (3) is fashioned from the neck on the same side as the breast to be dressed to the axilla on the opposite side. Weaving the bandage from the front to the back over the dressing using the loop as anchor allows the retention of dressings to the breast and again free motion of arms result and wet dressings can be applied.

This form of bandaging has been efficient and a great comfort to us to apply and has been enthusiastically received by the patients. We hope that other surgeons will try not only to use this principle on the specific locations described but also will devise other forms of loop bandaging in other locations.

VICTOR CARABBA, M.D.
Third Surgical Division, Bellevue Hospital
New York, N. Y.

REMOVAL OF BRILLIANT GREEN STAINS

IN REPLY to many inquiries concerning the removal of brilliant green stains from linen, the National Aniline and Chemical Company which manufactures the dye has furnished the following information.

(1) To every 4 ounces of hot soap solution add 1 tablespoon of ordinary hydrogen peroxide. Immerse clothing and leave for some time in the hot solution. Rinse well in cold water and dry.

(2) Stains can also be removed by immersing clothing in a solution prepared by dissolving about 200 grams of sodium perborate in 50 litres of hot water. After immersion the solution should be brought to a boil and allowed to boil for approximately one-half hour. Draw water off and run in fresh water and wash clothing thoroughly. If stains still remain, they can be easily removed by applying good soap or soap powder direct to the stained spots. Then thoroughly rinse and dry clothing.

(3) Almost any common bleaching agent on the market will remove stains.

JOSEPH K. NARAT, M.D.,
Chicago, Ill.

EDITORIAL ADDRESS

The office of the Editor of the Annals of Surgery is located at 386 Park Street, Upper Montclair, New Jersey. All contributions for publication, Books for Review, and Exchanges should be sent to this address.

Remittances for Subscriptions and Advertising and all business communications should be addressed to the

ANNALS OF SURGERY
227-231 South Sixth Street
Philadelphia, Penna.

ANNALS *of* SURGERY

Vol. XCVII

JUNE, 1933

No. 6

ELECTROSURGERY

A CLINICAL REPORT ON 118 OPERATIONS

BY HOWARD LILIENTHAL, M.D.

OF NEW YORK, N. Y.

AFTER an experience in more than 118 operations performed in whole or in part with the aid of electrosurgery, it becomes my duty to make a report embodying my opinion as to the cases in which this method of operating is applicable. I shall present a few brief illustrative histories and some suggestions concerning technic.

Gottesman, Perla, and Ziegler, in a paper published nearly two years ago,* presented the results of a study based upon animal experimentation in which the opinion was given that surgery of this type should not be promiscuously employed. Since then and in spite of this article electrosurgery has been increasing and its results, both immediate and remote, have been not only encouraging but often brilliant.

There are two important points in which it seems to me that the reporters have drawn unwarranted conclusions: First, that primary union is less likely to occur in a wound made by the electric method than in one made with the ordinary scalpel; and, second, that foreign-body necrosis with giant-cell reaction appears and that this is harmful. Farther on I shall discuss these two aspects of electrosurgery.

There are various units on the market for the production of a suitable bipolar electric current. This is not the place to describe and explain the physics of electrosurgery but those who are interested in this phase of the subject are advised to consult the excellent chapter in the recent book by Howard A. Kelly and Grant E. Ward.†

While it is undoubtedly desirable that the surgeon should know everything about his instruments I feel that the knowledge of the application and proper use of a piece of apparatus is more important than the details of its construction and the theory of its function. For example, in the use of the cystoscope it is not essential that the operator should understand all the optical details of the telescope with which he is working, although its general principles must, of course, be known to him.

The Incision.—With the instrument at my disposal in which the oscillations are extremely frequent I have been able to divide the skin by a rapid

* Surg., Gynec., and Obst., vol. li, p. 667, 1930.

† Electrosurgery. Howard A. Kelly, M.D., and Grant E. Ward, M.D., Chap. II, W. B. Saunders Company, 1930.

stroke, the tissues falling apart with no visible evidence of cauterization. Dr. Beverly Chew Smith* in a comparison of the microscopical appearance of sections of healed wounds following incision by knife and by electricity finds that the union is no less firm in one than in the other. Clinically, this is confirmed by my own experience. Upon applying the recently divided tissues to each other after electric incision there is immediate adhesion, and, this being more nearly aseptic than any scalpel wound can be, it is not surprising that rapid linear cicatrization occurs, whether the skin union was secured by metal clips, adhesive plaster, or by sutures. I am assuming, of course, that we are dealing with so-called clean cases. If infection is present it would be unreasonable to expect primary union by any method.

If current-oscillations are slowed down the division of the tissues becomes more and more associated with wider spreading of the area of coagulation and destruction of cells; and if the incision, even with rapid electric oscillations, has been made slowly a similar widening of the area of necrosis will take place and primary union will be less likely to occur.

The question, then, resolves itself into one of technic. We may compare in a similar manner the healing of a slow incision with a blunt knife with the result after the quick stroke of a keen edge.

By the electric method there is, perhaps, a little less bleeding from tiny points than is seen when the steel scalpel is used, but actual spurters, both large and small, must be caught with clamps in the usual manner. The next step in hemostasis, however, is one in which electricity has a great advantage over the ligature. A touch of the slow coagulation-point to the clamp, carefully isolated from all other instruments and from the surrounding walls of the wound will, in a second or two, seal the crushed vascular mouth with a firm eschar. A single wiping after the clamps have been removed should not be followed by hæmorrhage. Any vessel which bleeds after such sponging should be ligated.

The danger of infection by catgut or other ligature material I consider to be greater than that of recurrent hæmorrhage after sterile electrocoagulation. Catgut may harbor organisms as it comes from the tube or spool and, besides, it must be handled in tying the knot—even though with gloved fingers—thus subjecting it to at least one more possibility of infection.

As to the appearance of foreign-body giant cells in the presence of necrotic material it should be noted that these same cells are to be found in the neighborhood of any foreign body such as a ligature. I cannot understand why the mere presence of these cells should be regarded as undesirable. On the contrary, they have to do with the destruction and disappearance of the foreign body, whether this be a tissue eschar or a true *corpus alienum*.

ABSTRACTS OF HISTORIES WITH REMARKS AND SUGGESTIONS

My first case was one of apicloysis for the compression of a tuberculous cavity in the lung. In the method which I employ in this procedure the wound is temporarily

* Paper read at meeting of New York Physical Therapy Society at the New York Academy of Medicine and to be published in the Archives of Physical Therapy.

ELECTROSURGERY

closed and in a few days is reopened. Compression of the lung is accomplished by daily packing from the outside of the parietal pleura. I felt that here, even if an accident were to occur, the field would be easily accessible and any untoward situation could be remedied. In this instance the operation consisted in an incision beginning near the axilla and running downward and forward for about six inches. This opening was made with a quick long stroke, passing easily through the fatty layer down to the muscle. The pectoralis major was nicked at right angles for the sake of better exposure. The electric scalpel was abandoned on reaching the bony chest-wall, two ribs were resected subperiosteally in the ordinary manner and the intercostal vascular bundles were ligated with catgut. All other vessels were caught with clamps and when a dozen or more were in place each clamp was lifted and was touched with the coagulating current for about two seconds and then removed. There was no bleeding. Extrapleural packings were inserted and the skin was temporarily closed over these packings by heavy stitches to be removed in four days. At the end of this period I found, to my astonishment, the cutaneous wound healed not only primarily but so firmly that it required considerable effort to separate its edges. There was no bleeding when the packings were taken out and subsequent progress was satisfactory, the patient making an excellent recovery.

This first trial eliminated at once the fear that primary union would not take place in a wound correctly made by electrosurgery. Manifestly this was of no importance in the case in hand and it was for this very reason that I had selected it as a test. The fact that there was no bleeding, while very satisfactory, was not conclusive, for, after all, this was only one case, and to establish confidence in hemostasis in electrocoagulation there would have to be further observations.

Twice since then I have done this operation with perfect satisfaction so far as the electric scalpel was concerned.

In addition to the three cases of apicloyosis I present a list of other operations:

Thoracoplasty for pulmonary tuberculosis, twenty-eight operations upon fourteen patients. Pulmonary suppuration, twenty-seven operations upon ten patients. Chronic empyæma, eleven operations upon seven patients. Operations upon the chest-wall, seven upon seven patients. Carcinoma of the breast, six operations upon six patients. Carcinoma of the lung, four operations upon four patients. Appendicitis, nine operations upon nine patients. Cholecystectomy, six operations upon six patients. Inguinal and femoral hernia, six operations upon five patients. Operations for ranula, thyroidectomy, sebaceous cyst of the scalp, orchidectomy, osteomyelitis, one case each, eleven in all. In addition to these there were an indefinite number of phrenic neurectomies in which electrosurgery was used for hemostasis only.

OPERATIONS UPON THE THORAX.—These may be divided into two classes: Those in which the chest-wall alone was attacked, and those in which the organs within the thorax were operated upon. I have found without exception that electrosurgery is of enormous value in operations upon the chest-wall only, or as a preliminary to intrathoracic procedures.

CHEST-WALL.—*Non-malignant Tumors of Breast.*—Three cases, all extirpation of localized tumors. In none was there any mishap because of electrosurgery. The usual clean healing of the skin was the rule.

Carcinoma of the Breast.—In six cases of this disease, two of them complicated because of the necessity for immediate plastic operation, I found no cause to complain of the electric scalpel. Hemostasis by coagulation especially proved to be a great time saver. Primary union occurred in all these cases except one and here, on account of the unavoidable tension of a plastic procedure, there was necrosis of the edges of the skin for about three inches. Healing was complete five weeks after the operation, however, without further procedure.

There was one hematoma. It formed very slowly—more than a week after operation. This eventually necessitated reopening part of the firmly healed wound, after which there was prompt recovery.

In these mammary carcinomas I did not employ the electric method in dissection near the axillary vessels, but coagulation was employed except when a vessel spurted on wiping it after the forceps had been removed.

In the thorax as well as in other parts of the body I have been led to the conclusion that in sloughing or merely suppurating wounds ligatures might better be used than electric hemostasis. It is worth remarking, however, that even in these cases the entrance wounds when made through healthy skin healed with unusual rapidity.

Chest-wall. Miscellaneous.—The chest-wall alone was operated upon seven times. There was one carbuncle and I excised it with the electric scalpel. Of course, primary union was impossible but healing was rapid and without complications. In another case I had to deal with an area of movable chest-wall, several ribs having been resected with their periosteum by another surgeon long before. There was a small bronchial fistula at the centre of a large area of epithelialized lung. The electric scalpel was used to form skin flaps to cover the lung after its epithelial coating had been dissected away with scissors. The wound was drained at each extremity, but union of the flaps was perfect and final and rapid healing followed.*

Apicolysis.—Three cases. One has already been discussed and the other two showed nothing remarkable.

Thoracoplasty.—In the twenty-eight thoracoplasties there was much less bleeding than I have encountered when the ordinary scalpel was used, and the number of ligatures employed in the checking of spurting vessels was greatly reduced. Indeed, in one case, a secondary thoracoplasty where ten ribs were resected at one sitting, the entire operation was completed without the use of a single ligature. There was primary union. In another instance ten ribs were resected in two different sésances without employing a single ligature, and there was perfect primary healing.

In none of the other twenty-six operations had I the slightest regret for having employed the electric method. Occasionally a particularly rebellious spurter had to be tied but, as stated before, the total number of ligatures was very small.

* Surgical Clinics of North America, vol. xii, No. 2.

ELECTROSURGERY

I have found that when the electrode passes through muscular tissue there is violent twitching, and that this occurs whether the patient is operated upon under local or general anæsthesia. Kelly and Ward (*loc. cit.*) state that this contraction depends upon the number of current-oscillations. I have not had an opportunity to verify this but it would be an important factor in the selection of an electrosurgical apparatus. Of course, the manipulations about the bony structures, including the actual resection of ribs, must be performed with the usual bone-cutting instruments.

I am certain that in a thoracoplastic operation the time is shortened by at least one-quarter, perhaps even more. Healing is fully as rapid as I have found it when using the steel scalpel and ligatures, and the surgeon has an agreeable sense of security from infection. I have lately omitted the individual suture of muscle and fascial layers in these thoracoplasties, contenting myself with a few double silkworm-gut strands which pass through skin, fascia, and muscle. The cutaneous edges are approximated more exactly with metal clips. After all there is little or no tension because a section of the framework of the chest having been removed, the soft parts are actually redundant over a thorax of diminished capacity.

Another advantage of this form of surgery is the greatly diminished or even total absence of post-operative pain in the wound itself, which I imagine depends upon the destruction of the terminal portions of the divided sensory nerves.

INTRATHORACIC PROCEDURES.—In this list there are twenty-seven operations which were performed for suppurative diseases. I have not cared to employ the electric method here except for entrance through the skin and muscles of the thoracic wall, for fear of conduction of the electric current to the cardiac muscles with danger of arrhythmia, or even death from spasm. I have never seen a fatal case of this kind but I have heard of the accident and can well understand its physiology.

In the twenty-seven cases referred to I have seen no untoward phenomenon which could have been produced by the electric technic. There were four cases of pulmonary bronchiectatic disease with resection of a lobe or a part of a lobe and among them there has been no fatality; this, of course, not being by virtue of electrosurgery alone. It is merely mentioned in passing. The current was not employed within the chest.

Empyæma.—The eleven operations for chronic empyæma were extremely complicated and difficult, all seven of the patients having been operated upon before I saw them, some of them many times. Here, too, the electric incision was of greater importance than the hemostasis, which was usually accomplished by ligation with electrocoagulation as an adjunct. None of the patients has died. Four are long since recovered. One has a tuberculous pleural fistula and was operated upon merely to reduce the size of his empyæma. Two are still under treatment but are rapidly convalescing. It was in one of these cases that I learned the lesson that electrocoagulation may be unsafe in securing hemostasis in suppurating fields. There was a

severe secondary bleeding which demanded reopening of the wound. The patient is now nearly ready to be discharged from the hospital.

Carcinoma of the Lung.—There were four cases. No patient recovered, and in none was life shortened by electrosurgery.

ABDOMEN.—Appendicitis.—The skin incisions were made with the electric instrument. The fascia was cut with the scalpel or scissors and the remainder of the operation was completed in the usual manner. All vessels of the abdominal wall except the epigastrics were coagulated instead of being ligated. In seven of these cases there was primary union; in one there was a little exudate which was treated by opening the wound at its extremities and which finally healed before the patient left the hospital three weeks after her operation. In another instance the electric apparatus was not in perfect condition and the incision had to be made slowly. It was necessary to draw the wound edges in contact with adhesive plaster for some days after the skin clips had been removed.

Gall-bladder Disorders.—In six cases the gall-bladder was removed and it was in one of these that I learned to fear electric section of the aponeurosis. There was a separation of the wound six days after operation necessitating complete resuturing. The patient was an emphysematous man with a wide costal arch. While I believe that this accident might have occurred under any technic, I am willing to acknowledge the probability of added danger when an avascular tissue like the aponeurosis has to be divided and sutured.

One of the patients upon whom I operated for appendicitis had to have her gall-bladder removed at the same sitting. Because of faulty functioning of the apparatus the incision had to be made slowly. Here, too, the skin separated over a distance of about one-half inch and the entire wound was treated by firm strapping. Subsequent union was excellent.

In operations within the abdomen I have occasionally made use of the electric scalpel in dividing adhesions or in ablating organs, but I fear the accidental contact of the electrode with a mobile viscus and, therefore, prefer not to employ it as a rule in operations upon the abdominal organs.

Hernia.—Six cases of hernia (one of the femoral variety, the others inguinal) two of which were recurrent, were successfully operated upon with good results. Three of these, however, developed exudates, one of them purulent, evidently due to an infected chromicized catgut ligature. All of the patients, however, recovered perfectly, and since the skin only was electrically divided (not the essential parts of the hernia) I do not feel that the slight accidents could have been ascribed to the electric technic. In no case was the patient kept longer in the hospital than the usual three weeks. I feel that in this region of the body absolute sterilization of the skin is difficult and that the employment of a truly antiseptic knife is a distinct advantage.

Miscellaneous.—Of the eleven cases of miscellaneous operations nothing remarkable is to be reported.

CONCLUDING OBSERVATIONS.—(1) The rapidity and perfection of heal-

ing in cutaneous wounds depends upon the speed with which the incision is made.

(2) Only an instrument with extremely frequent oscillations is suitable for making the incision.

(3) The rate of healing of properly made wounds is equal to that of those made with the scalpel.

(4) The firmness of the immediate adhesion of the cutaneous edges compares well with that of ordinary incised wounds.

(5) Wounds made slowly or with an instrument whose electric oscillations are not sufficiently rapid do not heal as well as those made with the scalpel.

(6) The histological appearance of healed wounds electrically made differs from those in incised wounds but does not indicate tensile weakness, or any other undesirable quality. (Beverly Chew Smith, *loc. cit.*)

(7) An electrically made wound is more likely to be aseptic than one made with the knife.

(8) In checking hæmorrhage from the smaller vessels electric coagulation is much more speedy and quite as satisfactory as ligation. Large vessels should, however, be tied. There is to be found in the text of this paper a description of the application of the clamp and coagulation method applied to spurting vessels.

(9) In sloughing wounds there is danger of recurrent or secondary hæmorrhage no matter what method has been employed. Most surgeons will prefer the ligature in these conditions. Electrocoagulation is absolutely aseptic and no ligature can carry the same degree of certainty.

(10) When local anæsthesia is employed in the section of muscle there is a sensation of electric shock accompanied by contraction of the muscles as they are divided. Therefore, general anæsthesia is preferable in electro-surgery.

PRECAUTIONS.—In the immediate neighborhood of the heart it is believed that dangerous phenomena may occur because of muscular stimulation of this organ.

No metal instrument in contact with the skin or with other instruments should be touched with the electrode.

The electrode fastened to the patient's arm or leg must be firmly secured. It must not be in contact with wet drapings of any kind for fear of burning.

No electric spark should be employed near an explosive anæsthetic, nor near explosive cleaning fluids.

While working in the mouth electric contact with dental fillings and metal prosthetic appliances must be avoided.

It seems to be the impression among operators inexperienced in this kind of surgical procedure that its only important use is in the extirpation of malignant growths and that it should not be employed when first-intention healing is to be desired. As a matter of fact, electrosurgery as a routine is a distinct advance over the more usual methods.

THE DIAGNOSIS AND OPERATIVE CONTROL OF ACUTE PYOGENIC PHLEBITIS COMPLICATED BY GENERAL SEPTIC INVASION*

BY HAROLD NEUHOF, M.D.

OF NEW YORK, N. Y.

FROM THE SURGICAL SERVICE OF MOUNT SINAI HOSPITAL

AN ACUTE phlebitis of venous radicles occurring at the site of a primary infection is a pathological process which is an essential part of the infection but is not ordinarily a clinically recognizable or significant lesion. On the other hand an acute phlebitis, derived from and in close proximity to an infective focus which is usually secondary, is a frequent source of general septic invasion and thus a not uncommon cause of death. When phlebitis occurs the main venous trunk draining the infective or suppurative focus is commonly involved. The incidence of acute phlebitis, and in particular, of acute phlebitis of large venous trunks, in severe pyogenic infections, is perhaps much higher than is generally believed. In an analysis made by Aufses, Hirshfeld and myself of 150 patients at the Mount Sinai Hospital suffering from surgical septicæmia from a great variety of causes† 41 per cent. revealed a phlebitis secondary to a suppurative focus. The lesion was always well-defined, and readily demonstrable either at operation or at autopsy. The phlebitis was the immediate source of the general septic invasion in these cases. It was therefore the most important focus from which surgical septicæmia was derived. The series is sufficiently large and comprehensive to draw the conclusion that acute phlebitis is in fact the most common source of general septic invasion and therefore the feature of septicæmia to which close attention should be given. Furthermore, an important venous trunk, such as the jugular, the axillary, or the external iliac veins, was invaded in every instance in our series. It was the realization of the frequency as well as the ominous significance of the type of phlebitis in question which led to a clinical study of the subject and to the consideration of the possibilities of operative relief.

The classic clinical manifestations of septicæmia derived from pyogenic phlebitis are recurrent chills and fever, and metastatic foci, and the classic bacteriological evidence is a positive blood culture. This pathognomonic triad requires no discussion. It should be pointed out, however, that these absolutely distinctive features portray the full-blown picture. Furthermore, they are not invariably present and do not necessarily characterize the severest cases. Chills occurred in little more than half of the patients in the analysis of the Mount Sinai Hospital material to which reference has already been made. Typical septic fever existed in only 55 per cent. of the cases. The blood culture was always positive and metastatic foci were usually present,

- * Read before the New York Surgical Society, November 23, 1932.

† To be published.

only in the patients who died. An additional point of interest is the fact that, contrary to a widely held belief, phlebitis need not be accompanied by a richly positive blood culture. In at least one-third of the cases in our series the number of colonies per cubic centimetre was less than ten. There were several proven cases with negative blood culture.

The clinical picture and the significance of phlebitis of the lateral sinus and of the pelvic veins are known universally. On the other hand the significance of an identical clinical picture indicating the likelihood of phlebitis secondary to a focus of suppuration in adjacent soft parts does not appear to be very generally appreciated. Hence many efforts have been made to eradicate, surgically, relatively uncontrollable processes in the lateral sinus and pelvic veins whereas a much simpler and potentially more efficacious surgical attack on a phlebitis secondary to surface infection can be classed as a rarity. Some remarks are warranted therefore on the subject of phlebitis complicating infection of the soft parts. The recognition of the early stage is vital if operative control is to be attempted. A typical history antedating the phase of phlebitis is that of a distant and often insignificant primary infection, such as an infected blister of a finger or a pustule on the leg. This is followed by regional lymph-node involvement—axillary or femoral, for example—with a varying amount of fever. Sustained fever out of proportion to the degree of the adenitis should lead to the suspicion that infection is extending or has extended to the regional vein—the axillary or femoral in these instances.

Under other circumstances a frank axillary or femoral abscess has developed and has been incised. If fever persists and cannot be accounted for by the local findings, a phlebitis is to be suspected. A phlebitis is the most probable cause of sustained fever if the regional infective or suppurative focus has been adequately eliminated by operation and no other cause is discernible. Should a chill supervene, its repetition does not have to be awaited in order to recognize the existence of a phlebitis. The same statement holds of course for a positive blood culture. In my experience a collection of pus in the soft parts in the region of a venous trunk does not suffice to explain the clinical picture under such circumstances, no matter how large the abscess may be.

A phlebitis and usually a suppurative thrombophlebitis must be postulated and can be tentatively excluded only if the vein is exposed by operation and appears to be normal. A very important feature of the clinical course of the septic invasion from phlebitis from any source, and more particularly from phlebitis secondary to suppuration in the soft parts, is the apparently benign early phase that is often encountered. In not a few instances the patient does not appear ill for the major part of the duration of the general infection and only towards the end, when operative measures would probably no longer be of avail, is the full significance of the situation clinically appreciable.

It is evident from the foregoing that the diagnosis of phlebitis is easy

in the classical group, comprising about 60 per cent. of all cases, and may have to be based chiefly on exclusion in the remaining 40 per cent. There are occasional instances in which the inflamed vein can be felt as such. They are more than counterbalanced by cases in which its existence cannot even be suspected on clinical grounds and in which a working diagnosis of phlebitis must be made empirically.

The pathological process in the infected vein has been the subject of a considerable literature which deals chiefly with the various forms of phlebitis as they are encountered in their final advanced stages at autopsy. Any relationship that may exist between the type and degree of phlebitis and the clinical course has received scant attention. As far as my limited experiences go I have been unable to determine definitely any relationship between the two although I have gained an impression to which reference will be made.

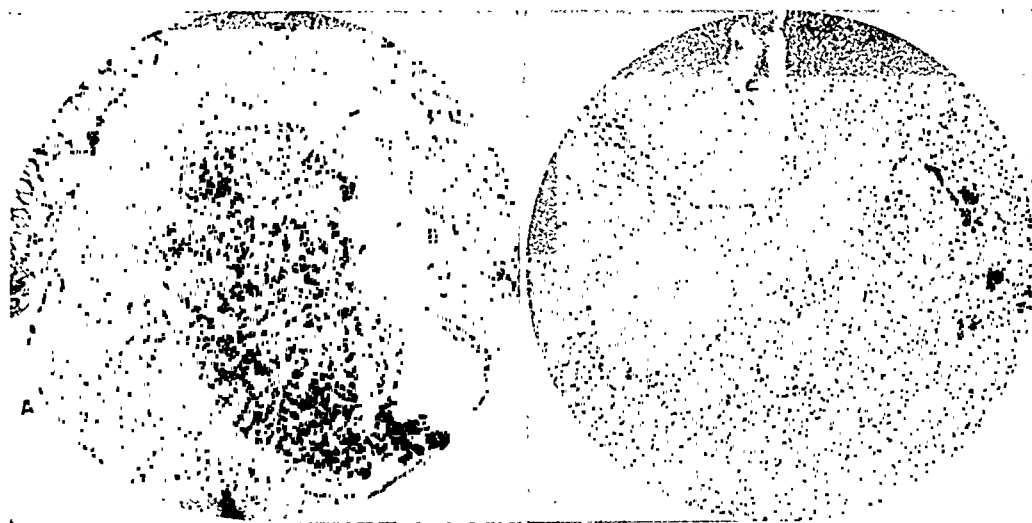


FIG. 1.

FIG. 2.

FIG. 1.—Cross-section of the axillary vein showing early acute phlebitis. There is leucocytic infiltration of the wall of the vein with scanty bacteria at A, none at B. No thrombosis in any of the sections taken from various parts of the vein. (From Case IV.)

FIG. 2.—Cross-section of brachial vein removed at a later date in the same case. The wall of the vein is greatly thickened and there is diffuse leucocytic and bacterial invasion with purulent thrombosis.

Many observations will be necessary in order to acquire worth-while information on this surgically important question.

The degree of phlebitis which I have encountered at operation ranged from slight changes in the wall of a patent vein to the characteristic white-walled vein expanded about its adherent purulent thrombus. Other varieties noted at operation were an infected vein converted into an almost obliterated cord-like structure, a slightly inflamed vessel containing fluid pus, a whitened, thickened vein containing fluid blood, and a lesion which is essentially an inflammatory or a suppurative periphlebitis.

Details of the microscopical examination of excised specimens of veins will not be given, but three points of surgical moment, gained from the histological study, should be stressed. The first is that the degree of acute

ACUTE PYOGENIC PHLEBITIS

phlebitis, with its invasion of the intimal and subintimal zones by bacteria and polynuclear leucocytes, cannot be estimated accurately by the gross appearance of the vein at the time of operation. The second point is that phlebitis may be found upon microscopical examination at a site at which the vein appears entirely normal in cases of phlebitis not associated with thrombosis. Finally, a severe clinical course may ensue from a phlebitis which is not accompanied by thrombosis. In fact, it is my impression that the macroscopically (gross) thrombophlebitic type may give rise to a comparatively less virulent form of septic invasion although I have some evidence to indicate that the non-thrombosed may be converted at a later stage into the typical thrombophlebitic variety. There is certainly no present means of determining if an acute phlebitis without thrombosis will persist

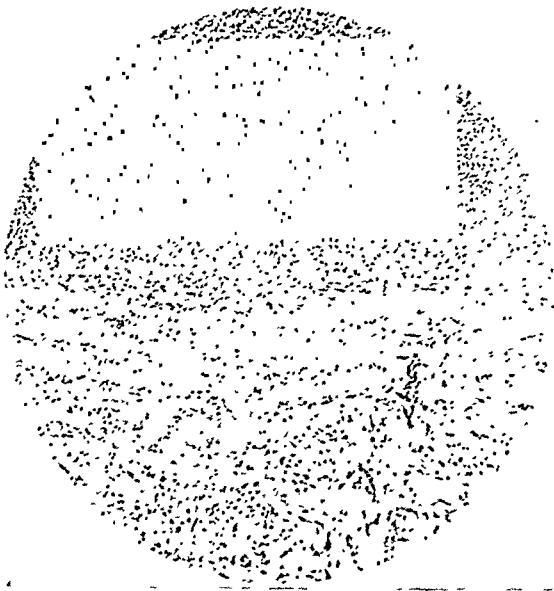


FIG. 3.

FIG. 3.—Purulent thrombophlebitis of the axillary vein. There is œdema, leucocytic infiltration and new-formed vessels in the subacutely inflamed vein, and an adherent purulent thrombus. (Case III.)

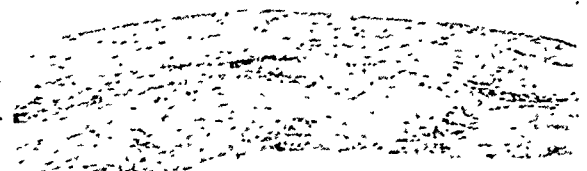


FIG. 4.

FIG. 4.—Normal axillary vein in the section proximal to the site of thrombophlebitis in the previous case.

as such throughout the course in any given case. The bearing of these observations on the question of treatment will be noted.

There can be no doubt of the fact that phlebitis of a surgically accessible and recognizable vein is the feeding focus of surgical septicæmia in many cases. There can also be no doubt of the terrific mortality under so-called conservative treatment although occasional recovery with non-interference unquestionably occurs. It is probably the picture of the great extent of the phlebitic process so often seen at autopsy which leads to a sense of futility as far as a surgical effort at its control during life is concerned. Nevertheless, the otological surgeon, working in a cramped space and on a structure that cannot be safely excised, is not daunted by this picture and achieves tangible results in lateral sinus phlebitis. There is every logical reason for believing that his results as far as saving of life is concerned can at least be matched and in all probability be surpassed in the more accessible general

surgical fields. Whereas he must often temporize by evacuating a thrombus and leaving behind the infected vein, the general surgeon can often remove without danger the vein bearing the lesion. The only striking difference of which I am aware between sinus phlebitis and phlebitis elsewhere is the slower evolution of the clinical manifestations in sinus phlebitis in many instances.

It is because phlebitis associated with general surgical infections usually spreads so rapidly and often leads to death from septicæmia so quickly that the indication for operation is truly urgent. In my opinion the indication exists not only when a definite diagnosis has been made, but also when the probability of phlebitis is seriously considered. There is quite as much justification for exploratory operation for suspected pyogenic phlebitis complicated by general septic invasion as for other suspected lesions. Phlebitis was encountered at operation in every instance and usually to an extent but little suspected in all the cases in my experience. The exceptions I would offer to the indications for operation are the unusual cases in which the clinical picture is of a continuously benign character, a phlebitis involving many veins that cannot be traced, and of course surgical interference with a venous trunk whose patency is essential to life. It would lead too far afield to enter into a discussion of indications for or against more extensive operations which would also include elimination of the phlebitic process. For example, amputation of a limb for septicæmia *versus* drainage of infection and operation for the phlebitis in that limb might be a matter for careful consideration. In such a case, however, amputation, if decided upon, would probably not suffice unless the process in the vein were completely eradicated as well. Conceding the possibility of spontaneous subsidence of phlebitis after the elimination of the causative infection, there is never any assurance of such an issue. The gamble on spontaneous subsidence is a dangerous one when a phlebitis is the source of a septicæmia.

An operative treatment for pyogenic phlebitis complicated by general septic invasion must be based on a plan for complete elimination of that focus. Proximal ligation of the vein should be considered a temporizing method. That that procedure may have to be employed on the pulmonary vein or the portal vein, or on the left subclavian vein because of the thoracic duct, is obvious. However, its advocacy as the principle of treatment is illogical for two reasons; first, the infective and oftentimes suppurative process of and in the vein is left behind to extend peripherally to an uncontrolled extent, and, secondly, the feeding focus may continue to infect the circulation through parallel venous trunks. Proximal ligation of the vein should be classed as an operation which is more apt to fail than to succeed in its purpose, and should be reserved for circumstances in which more effective operations cannot be practised. In the face of a desperate or potentially desperate situation, a temporizing operation has little to commend it when a more definitive one is available. The procedure I wish to advocate is the excision of the vein at the site of phlebitis, the excision to be carried beyond

ACUTE PYOGENIC PHLEBITIS

the visible limits of the phlebitic process whenever feasible. It is difficult to understand the objections to this plan. There should be no fear of œdema resulting from excision of a main venous trunk, because the evidence is clear, I think, that œdema is due to lymphatic and not to venous obstruction. For example, I have excised the entire axillary vein on several occasions, the right subclavian, the common femoral, and the external iliac veins, without observing any œdema of the extremities. Furthermore, there should be no great compunction about the elimination of the vein as a blood carrier since that function will be more or less lost as the result of the more or less obliterating lesion within its lumen.

The technic of operation is based essentially on liberal exposure of the vein at the site of phlebitis or suspected phlebitis. After the presence of phlebitis has been established and excision is decided upon, the operative

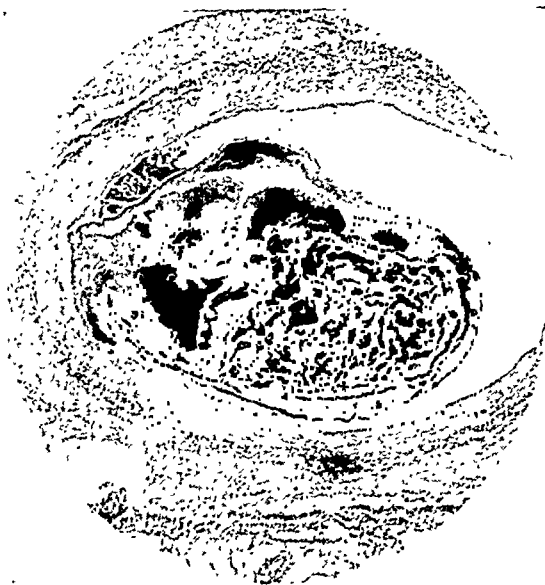


FIG. 5.



FIG. 6.

FIG. 5.—Purulent thrombophlebitis of external iliac vein, showing maximal inflammation of the wall of the vein at the site of the adherent thrombus. The vein was normal at no great distance from the proximal limit of thrombosis.

FIG. 6.—Purulent thrombophlebitis of the internal jugular vein. (Case VIII.) Note that the phlebitis continues below the termination of the thrombus (to the end of the specimen removed at operation).

exposure of the vein is extended beyond the limits of phlebitis whenever feasible. Considerable sacrifice of structures may be required for such exposures, as illustrated in some of the case reports. Special attention should be given to adequate operative exposure proximal to the end of the lesion, because excision is to be performed beyond the limits of the phlebitis. This step has been responsible, I believe, for the fact that phlebitis proximal to the site of excision was not found at autopsy on the patients who died after operation (see case reports) when excision beyond the limits of phlebitis was performed. Furthermore, the blood cultures in these cases, which had been richly positive before operation, became negative or presented scanty growth after excision. Excision from a point proximal to the site of phlebitis has also been the reason for the successful results, in my opinion. Either a serrefine or a temporary ligature is placed on the proximal portion

of the vein before dissection of the vein is carried out. The release of the vein from inflammatory tissue or suppurative areas in which it may be embedded has been difficult on a few occasions.

A plane of cleavage between the vein and surrounding tissues can always be found, however, and the dissection in this plane will isolate the vein for its excision in one piece. The question of the method of dealing with involved branches of the infected venous trunk is an open one. It has not been my practice to dissect them out for any distance because I believe that that dissection is not essential, and in addition would lay open too many tissue planes. It may be argued, however, that the blood-stream might become infected anew by way of these involved tributaries. I know of no evidence to indicate that this can occur unless there are parallel communicating trunks, and in actual practice it has not been noted.

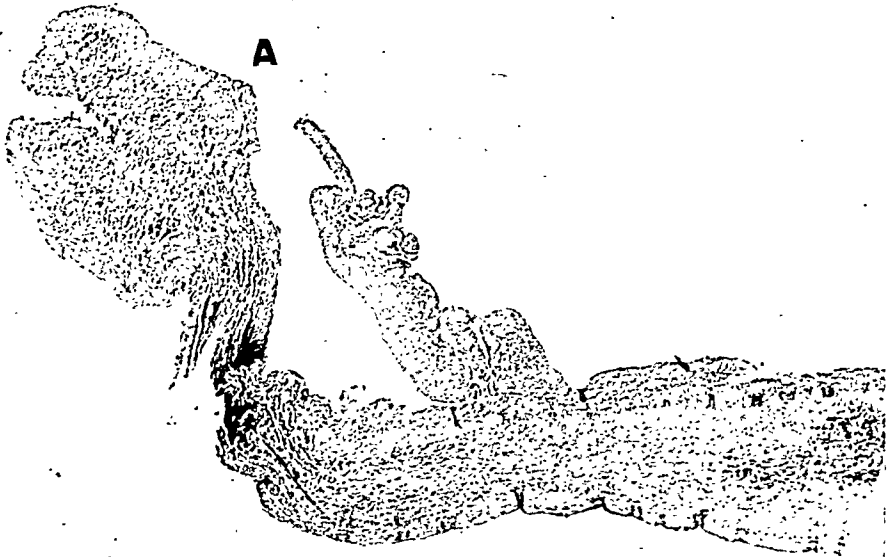


FIG. 7.—Purulent thrombophlebitis of the innominate vein removed at a later date in Case VIII. There is an elevated parietal thrombus. The phlebitis continued below this toward the heart, to terminate at A.

The problem of excision of the vein in the presence of thrombophlebitis (the most common lesion) is a straightforward one, for the microscopical alterations in the vein do not extend very far beyond the visible and palpable site of the lesion. On the other hand the question as to the procedure to be employed when phlebitis without evident thrombosis is encountered cannot be answered unreservedly at the present time. In such instances the microscopical examination reveals a diffused infection of the wall of the vein with minimal or no thrombosis. Infection may be present to the same degree where the vein appears normal as at the site of visible phlebitis. This was the case in one patient whose axillary vein was excised. (Case IV.) Although there was no evidence of further infection from the proximal stump after operation a typical pyogenic thrombophlebitis of the whole brachial vein

ACUTE PYOGENIC PHLEBITIS

developed (see case report). The excision of the axillary vein may have been the cause, or the relatively slight phlebitis of the axillary vein may have been the first stage of thrombophlebitis. With the evidence at hand, excision or incision or any other effort at immediate elimination of the focus cannot be advocated in the treatment of phlebitis without thrombosis. Under the impression that the thrombotic phase would be desirable, tending to localize the zone of phlebitis, I shall in future cases attempt various methods at exciting thrombosis when phlebitis without thrombosis is encountered at operation. One method would be the application of the coagulating current to the wall of the vein at the site of phlebitis, the operation to be terminated by placing a pack snugly against that site. Excision could then be practised several days later if in fact thrombophlebitis was noted at the second exposure of the vein. In the case of the lateral sinus the thrombus could be evacuated in the customary manner. Procedures along such lines should be tried, in my opinion, rather than primary excision or other operative efforts in the presence of phlebitis without obvious thrombosis.

The following case reports comprise the experiences in recent years. The records of earlier operations, especially those performed during the period of the World War, are unfortunately not available. It can be stated, however, that the experiences parallel those described in the case reports. The first two cases illustrate what may be termed the pre-septic phase of pyogenic phlebitis.

CASE I.—*Acute Phlebitis and Periphlebitis of the Dorsal Vein of the Foot. Excision. Recovery.*—(Mount Sinai Hospital No. 336367.) Male, forty-six years old. Admitted with a history of a swelling on the dorsum of the right foot of four days' duration, accompanied by fever. The patient ascribed the lesion to constriction by a tight shoelace. On admission the temperature was 101.2° . There was moderate swelling and marked redness on the dorsum of the foot. The redness extended above the ankle, shading off rather abruptly over the inner aspect of the mid-calf. The appearance suggested erysipelas but was not distinctive. In the midst of the swelling on the dorsum of the foot there was felt a narrow elongated mass which was exquisitely sensitive. This was interpreted as a phlebitis of the dorsal vein of the foot. At operation this vein was found to be the seat of a phlebitis which diffusely involved the vessel for a distance of about two inches. It was surrounded by multiple punctate abscesses. The vein appeared normal beyond the indicated limits. Its branches at the site of phlebitis were apparently not involved. The vein was excised well beyond the limits of the lesion and the wound was packed. The erysipelas-like, widespread redness of the skin subsided immediately after operation. The wound went on to rapid healing.

CASE II.—*Pyophlebitis and Periphlebitis of the Dorsal Vein of the Foot. Excision. Recovery.*—(Mount Sinai Hospital No. 335804.) Male, thirty-five years old. Was admitted with a history of long-standing epidermatophytosis of both feet. Six days before admission redness and soreness of the second toe of the right foot developed. Three days later pain and redness appeared on the dorsum of the foot. A day later pain was noted in the popliteal and femoral regions. The day before admission the patient felt chilly and five hours before admission there was a shaking chill of fifteen minutes' duration. The admission temperature was 103.8° which fell to subnormal the next day. There was a localized infection about the nail bed of the fourth toe with some œdema over the dorsum of the foot. Here there was felt a rather firm, not fluctuant, tender swelling about an inch long and one-quarter of an inch wide. It lay in the long axis of

the dorsum of the foot and directly beneath the skin. There was no overlying increased heat and no lymphangitis. Several femoral lymph-nodes were tender to pressure, but were soft and discrete. In a consideration of the nature of the lesion the interpretation narrowed down to a probable suppurative phlebitis, for there was no evidence of abscess formation or spreading infection and the source of the chill and high fever was apparently derived from the lesion on the dorsum of the foot. The blood culture was negative.

Operation was done on the second day after admission when the temperature was 99.6°. An incision was made over the swelling on the dorsum of the foot and infiltrated tissue was encountered. Several minute suppurative foci were traversed to expose a firm, longitudinal mass. The vein leading into it was dissected free and found to be thick-walled and patent. Two veins leading out from the mass were similarly thick-walled and patent. After these were tied off the mass was excised and the wound packed. Upon cutting across the mass it was found to be a collection of fluid pus within the lumen of a thick-walled vein. The lesion was therefore a suppuration within a vein with multiple areas of suppurative periphlebitis. The progress of this lesion on non-operative treatment would have been in one of two directions: either the gradual evolution of the multiple areas of suppuration about the vein or progressive invasion of the blood-stream via the patent venous trunk communicating with the collection of pus within the vein in the infected field.

The post-operative course was uneventful. There was no post-operative rise in fever and the patient was discharged on the sixth day with a clean, superficial, healing wound. The infecting organism was a hæmolytic streptococcus.

CASE III.—*Suppurative Thrombophlebitis of the Axillary Vein. Septic Course Characterized by Unusually High Fever. Excision of Axillary Vein. Prompt Disappearance of Bacteria from the Blood-stream. Recovery.*—(Mount Sinai Hospital No. 313362.) Male, thirty-six years old. Admitted with a ten-day history of chills with fever ranging from 104° to 108.5°. There was an upper respiratory infection at the onset as well as an infected (?) blister on the left thumb. On admission physical examination was negative except for a healed blister of the thumb and a red throat. A left ethmoiditis was found but the lesion was interpreted as not being a suppurative one. During the patient's stay of one week before operation there were several chills followed by rises of temperature to 106.8°, 107°, and 108.2°. Axillary fullness was noted as well as a metastatic focus in the right elbow and in one phalanx of a finger. Blood culture was positive for hæmolytic streptococcus. There was the evidence of a left subpectoral abscess when the patient was seen by me one week after admission. I therefore interpreted the septic state as being derived from a suppurative phlebitis of the axillary vein.

At operation an incision was made across the axilla which was later extended to sever transversely the pectoralis major. A very large multilocular subpectoral abscess was evacuated, the pus being sacculated in several pockets. A shelf of tissue between two of the collections led to the region of the axillary vein. On dividing the shelf inflamed axillary lymph-nodes were found adjacent to the vein. The latter in its second portion was white, thickened, and expanded around a thrombus which was about an inch long. The first portion of the axillary vein presented the tapering off of the phlebitic process and was of normal appearance near the apex of the axilla. The lesion tapered off similarly into the third portion of the axillary vein. A ligature was placed on the first portion of the axillary vein and the vein was then dissected out of the dense, inflammatory bed which agglutinated it to the surrounding structures and particularly to the axillary artery. All the branches of the vein appeared free from involvement. The vein was excised down to its junction with the brachial. Upon opening the specimen the adherent purulent thrombus was found to be about two inches long with mesial rounded and distal tapering ends. The wound was packed.

Microscopical examination of the excised portion of the axillary vein showed a thrombophlebitis with large numbers of bacteria. The sections taken from the proximal

ACUTE PYOGENIC PHLEBITIS

and distal ends revealed normal vein. In this case microscopical examination showed that the phlebitis did not extend far beyond its macroscopical limits.

The blood culture was negative shortly after operation. Improvement in the septic state set in promptly. There was oscillating fever for two weeks after operation due to peripheral metastatic foci, some of which required incision and drainage. Others subsided spontaneously. In particular a pyarthrosis of the right shoulder of bacterial nature as demonstrated by the culture of the aspirated pus (hæmolytic streptococcus) subsided spontaneously. The patient was discharged with healed wounds five weeks after operation and the follow-up revealed normal function of the left upper extremity. At no time after operation was there œdema in this extremity.

CASE IV.—*Acute Phlebitis of the Axillary Vein without Thrombosis. Excision. Suppurative Thrombophlebitis of the Brachial Vein. Excision. Recovery.*—(Mount Sinai Hospital No. 335973.) Male, twenty-eight years old, sustained an injury to the fourth finger of the right hand seven days before admission. He expressed a drop of pus from the site of injury three days later. The following day there developed axillary pain, nausea, vomiting, and diarrhœa. There was high sustained fever and chilly sensations, but no definite chills. The admission temperature was 105°. There was a localized infection of the finger, no lymphangitis, and a tender mass in the right axilla. The patient's physician stated that there had been no lymphangitis before admission. There was limited abduction at the shoulder and the axillary swelling became more obvious when the arm was abducted to a right angle. It could then be more easily examined and was interpreted as a mass of discrete, inflamed lymph-nodes. In the absence of lymphangitis, axillary or sub-pectoral abscess, the sustained fever was ascribed by exclusion to a phlebitis of the axillary vein. An exploration of the axillary mass and of the axillary vein was therefore decided upon. A blood culture was taken and showed no growth.

At operation the day after admission an incision was made across the axilla and carried over the surface of the lateral border of the pectoralis major. The latter was severed at a later stage when approach to the first portion of the axillary vein was desired. Several enlarged lymph-nodes were encountered in the mid-axilla, and one which was unusually large and soft was removed. Its removal exposed the axillary vein in its mid-portion. (The removed lymph-node when cut across showed several areas of necrosis.) Between several of the soft lymph-nodes there were two small collections of thin pus. The portion of the axillary vein exposed by the removal of the enlarged lymph-node was found to be reddened, lustreless, and obviously inflamed. Further dissection of the axillary vein revealed a similar change to a lesser degree toward the apex of the axilla. At the very apex the appearance of the vein was normal. The distal portion of the axillary vein was similarly quite normal in appearance. A ligature was placed on the vein at the apex of the axilla, another on the vein at its junction with the brachial. The branches were tied off and the vein was removed in one piece. The wound was packed. After the vein had been excised some of the contained blood was withdrawn under antiseptic precautions and cultured. The report of the culture was hæmolytic streptococcus.

An erysipelas-like infection about the wound developed soon after operation. The temperature slowly subsided to reach below the 102° level on the ninth day. By the eleventh day there was the fully developed evidence of a phlebitis of the brachial vein. The latter was converted into a localized, tender, cord-like infiltration extending down to the bend of the elbow, surrounded by brawny œdema and redness of the overlying skin. Pus escaped from the axillary wound upon pressure over the upper end of the obviously thrombosed brachial vein. Excision of the brachial vein was done through an incision exposing the full length of the vein. Infiltrated tissue was encountered and the identity of structures was not easy because of this and because of very free oozing. The median nerve was dissected away and the vein exposed. Throughout the limits of the exposure the brachial vein was white, thick-walled, and by palpation could be interpreted as con-

taining a firm thrombus. It was embedded in inflammatory tissue from which, however, it could be readily shelled when the proper plane of cleavage was found. The dissection was continued to within a short distance of the elbow, although there was no evidence of the termination of thrombophlebitis at this level. All the branches were similarly involved. The brachial vein was removed without placing a ligature at the lower end because it was thought that if suppuration supervened at this end pus would be permitted to escape. Upon cutting across the specimen at different levels, it was found that the maximal degree of phlebitis existed at the upper level, but the lesion was advanced throughout. The incision was lightly packed.

The clinical course was satisfactory after excision of the brachial vein. Fever subsided progressively and temperature was normal in a week. The patient was discharged about three and one-half weeks after excision of the axillary vein with clean, granulating wounds. He was seen at follow-up two months later at which time there was full motion at the shoulder- and elbow-joints, and good power.

The microscopical examination of the axillary vein showed the same degree of phlebitis in sections taken from the proximal portion as from the mid-portion, namely, definite but not severe inflammation of the walls with bacterial invasion. There was no thrombosis in any of the sections. The brachial vein showed a severe thrombophlebitis in all sections. It is interesting to note that so severe a thrombophlebitis, accompanied by rich bacterial invasion, could exist in the brachial vein and its branches without corresponding clinical manifestations. This can be accounted for by the fact that the vein was cut off from the general circulation. The branches of the brachial vein, which were involved to the same degree as the parent trunk and which were not excised, did not by communication feed the blood-stream. This feature therefore supports the statement made in the body of the paper to the effect that side branches need not be dissected out unless they communicate with a parallel venous trunk.

CASE V.—Acute Thrombophlebitis of Axillary Vein. Drainage of Axillary Abscess. Excision of Axillary Vein. Cessation of Bacteriæmia. Death from Multiple Abscesses of the Lungs.—(Mount Sinai Hospital No. 265618.) Male, twenty-four years old. Sustained an incised wound of the left index finger five days before admission. Two days later superficial infection of the finger was noted together with pain in the left axilla. The latter was progressive and generalized pains and fever developed. On admission the temperature was 103.6°. There were enlarged and tender left axillary lymph-nodes. Fever subsided but rose on the fourth day to 104°. Blood culture taken on that day was sterile. Two days later there was a chill followed by rise of fever to 105.2°. A blood culture was taken but operation was proceeded with before the result could be known.

At operation by another surgeon an axillary abscess was evacuated. The day after operation a report on the blood culture was made, 200 colonies of hæmolytic streptococci per cubic centimetre being present. There was a second chill that day and with that chill and the positive blood culture there could be little doubt as to the existence of a pyogenic phlebitis. At operation an incision was made across the axilla severing the pectoralis major and subsequently the pectoralis minor. There was no retention of pus in the drained abscess. Inflammatory tissue was traversed and inflamed lymph-nodes dissected away in order to expose the axillary vein. The latter was intimately adherent to surrounding structures in its mid-portion. Here it was white, thickened, and contained a large thrombus. The lower limit of the phlebitic process was much more obvious than the upper. Accordingly the normal brachial vein was ligated and the axillary vein dissected out in retrograde fashion. Upon traction on the freed vein the upper limit of the phlebitic process could be visualized and a ligature was placed on the normal third portion of the subclavian vein. The branches of the axillary vein at the site of the thrombotic process presented recent thrombi where they were divided between ligatures at some distance from the axillary vein. The other branches of the vein appeared free from phlebitis. The vein was excised in one piece and the wound packed.

ACUTE PYOGENIC PHLEBITIS

Microscopical examination of the vein revealed a severe thrombophlebitis which terminated well within the limits of the specimen. The septic state was maintained after operation, fever ranging between 102° and 105° until death ensued eighteen days later. A blood culture taken the day after operation disclosed two colonies of hæmolytic streptococci per cubic centimetre, a subsequent one, five colonies, and the remaining ones (five in number) were sterile. The maintenance of the septic state was due to a metastatic pleural infection which was drained, a pyarthrosis of a knee-joint which was aspirated, a pararectal abscess which was drained, and presumably to multiple abscesses of the lungs. At autopsy innumerable abscesses of the lung were found. There was as well fluid pus in the phlebitic left brachial vein. The left subclavian vein was found entirely free from phlebitis. In commenting on this case it can be assumed that the multiple abscesses of the lung developed at an early phase of the septic state, before the axillary vein was excised. The excision of the vein succeeded in controlling further invasion of the blood-stream. The phlebitis of the brachial vein can be compared with that noted in the former case and it was therefore probably of no great significance in the maintenance of the septic state.

CASE VI.—*Phlebitis of Jugular Vein. Putrid Abscess of Neck. Excision of Vein. Drainage of Abscess. Recovery.*—(Mount Sinai Hospital No. 312108.) Male, forty years old. A gangrenous tonsillar abscess was incised three days before admission. Fever, which had been present before, rose to a high level (106°). A swelling on the left side of the neck developed together with a euphoric state. On the day of admission there was a severe chill of a half hour's duration. On admission the patient was excitable, restless and flushed, profoundly prostrated, and euphoric. The left tonsil was the site of an incised wound with somewhat necrotic margins. There was a pronounced widespread fullness on the left side of the neck extending from the mastoid process down to the root of the neck.

Operation was performed directly after admission with the diagnosis of deep suppuration complicated by a phlebitis of the jugular vein. Under local anæsthesia a free incision was made in front of the sternomastoid which was retracted laterally. The internal jugular vein was exposed and found to be thickened, lustreless and elevated by inflamed lymph-nodes in its mid-portion. In the lower part of the neck it was free from evidences of phlebitis. The vein was therefore tied off at this level. It was exposed above the site of phlebitis, found to be of normal appearance, and ligated. The vein was then excised. Beneath it the carotid sheath was exposed and a foul abscess on and beneath the sheath was evacuated. The suppurative tract led directly to the lateral wall of the pharynx. The tract was split open for adequate drainage and ventilation.

Improvement began shortly after operation, fever soon subsiding and the septic state rapidly disappearing. The anaërobic infection was treated by oxygenation. The patient was discharged with a healing wound eighteen days after admission. In this case the prompt disappearance of the septic state cannot be ascribed solely (or perhaps at all) to the excision of the jugular vein. The evacuation of the deep cervical abscess may have been the definitive step.

CASE VII.—*Proliferative Phlebitis of the Axillary, Subclavian, and Innominate Veins. Partial Excision of the Subclavian Vein. Ligation of the Innominate Vein. Death.*—(Mount Sinai Hospital No. 319434.) Male, forty years old. Entered the hospital with a history of onset of sore throat and dysphagia eleven days before admission. There was fever, and on the diagnosis of quinsy an incision was made (but no pus obtained) five days before admission. Fever continued, swelling appeared in the lower part of the neck, patient became irrational and icterus developed. Physical examination on admission revealed a disoriented and confused individual. There was a hepatosplenomegaly apparently of long duration and unrelated to the acute illness. At the root of the neck there was a reddened, indurated swelling interpreted as a deep cellulitis. A blood culture taken shortly after admission was positive (40 colonies of hæmolytic

streptococci to the cubic centimetre) and the patient was obviously suffering from a sepsis derived from a phlebitis.

At operation an incision was first made over the swelling at the root of the neck and nothing other than devitalized inflammatory tissue was encountered. The internal jugular vein was exposed and presented no significant changes. Further exploration behind the clavicle disclosed the same type of devitalized tissue which was now met in the region of the subclavian vein. The latter was then exposed and found to be converted into a greatly thickened, cord-like structure embedded in inflammatory tissue. The dissection was continued to expose the axillary vein which was also the seat of a similar process and similarly embedded in devitalized inflammatory tissue. No pus was encountered. The proximal end of the phlebitic process was not exposed for two reasons: first, because of the fact that the thoracic duct was presumably in the operative field, and secondly, because suppuration was not encountered and the lumen of the vessel appeared obliterated. A section of the lateral portion of the subclavian vein together with an adjacent part of the axillary vein was removed. There was no bleeding from either end although ligatures were not applied. At the end of the operation the dictated comment was that the situation was not clear and that the plan was to proceed with an effort at reaching beyond the central end of the phlebitis if the septicaemia continued. Microscopical examination revealed a subacute proliferative type of phlebitis without thrombosis. A blood culture taken the day after operation disclosed a vast increase in the number of colonies of hæmolytic streptococci (more than 400 colonies per cubic centimetre). Fever was low. Two days after the first operation the effort was made to ligate the innominate vein beyond the limit of phlebitis. Sections of the first and second costal cartilage were removed together with the mesial two inches of the clavicle, through a curved incision. The anterior mediastinum was entered and the cord-like subclavian vein was exposed. It was followed into the mediastinum and the tissues overlying the innominate vein were separated. The vein was found to be a stiff white tube enveloped in inflammatory tissue. It was followed to within a short distance of the pericardium at which site the inflammatory process tapered off. A ligature was placed at the level of termination of phlebitis and securely tied. Excision could not be performed because of the inevitable damage to the thoracic duct as well as the unsatisfactory condition of the patient. The wound was packed. The patient's condition did not improve after this operation and he died with the picture of continuing infection.

At autopsy the innominate vein was found to be normal at and proximal to the site of ligature. Distally the innominate and the unexcised portions of the subclavian and axillary veins were the seat of the same type of phlebitis which characterized the excised specimen. There were no metastatic foci. The source of the phlebitis in the axillary, subclavian and innominate veins could not be definitely determined. Attention is called to the evidence that the inadequate first operation was not only followed by continuation of the septic state, but also by its intensification, if the vast increase in colonies in the blood-stream can be accepted as a guide.

CASE VIII.—*Thrombophlebitis of Lateral Sinus and of Jugular Vein. Evacuation of Thrombus from Lateral Sinus. Excision of Jugular Vein. Continued Bacteriæmia. Excision of Innominate Vein for Phlebitis without Thrombosis. Cessation of Bacteriæmia. Death from Meningo-encephalitis.*—(Mount Sinai Hospital No. 322025.) Male, fourteen years old. Admitted to the otological service with a five-day history of right-sided otitis followed by the development of mastoiditis. At operation shortly after admission a suppurative mastoiditis was encountered and there was as well a peri-sinus abscess which was drained. Fever was sustained at a high level after operation and symptoms of severe meningeal irritation appeared. There were no chills. Blood culture was positive (hæmolytic streptococcus).

Four days after the mastoidectomy tenderness and a cord-like resistance were felt along the course of the jugular vein. The diagnosis was a phlebitis extending down the

ACUTE PYOGENIC PHLEBITIS

vein to an undetermined extent. Operation on the jugular vein was proceeded with. The vein throughout the operative field was thickened and whitish, filled and emptied with respiration, but contained no blood. Through its wall there could be felt a thrombus terminating in the lower part. The vein was freed and tied off at the root of the neck well beyond the limit of the thrombus. It was then dissected out to within a short distance of the mastoid process. The specimen showed a thrombus about an inch long in the mid-portion of the jugular vein. The otological surgeon then proceeded with the treatment of the sinus phlebitis, the operation consisting in opening the sinus and removal of its contained purulent thrombus until free bleeding was obtained from both ends.

Microscopical examination of the excised jugular vein showed that acute phlebitis existed at the lower end of the vein well beyond the limit of the adherent infected thrombus. The clinical picture of severe meningeal irritation persisted after operation and the blood culture remained positive. Fever was sustained, somewhat irregular, and there were no chills. The spinal tap was negative for bacteria although there were the evidences of an inflammatory reaction in the meninges.

A week after the operation on the jugular vein and lateral sinus, the continuing sepsis was interpreted as referable to uncontrolled phlebitis below the limit of the jugular vein. Accordingly, operation was performed for the purpose of exposing the stump of the jugular and the course of the innominate vein. The incision began at the root of the neck, extended downwards in a curved fashion across the inner third of the clavicle over the anterior chest wall. The sternoclavicular joint was entered and was found to contain a small amount of pus. The proximal third of the clavicle was laid bare and excised with a Gigli saw. The anterior mediastinum was then entered. The innominate vein could not be identified at once and accordingly the stump of the jugular vein where it had been ligated was found. It was thick-walled and whitish and was employed as a guide for the exposure of the innominate vein. The veins entering the latter presented no abnormality and they were tied off as they were met. The junction with the subclavian vein was exposed and the subclavian vein was found to be normal. Exposure of the innominate vein showed it to be white-walled and firm in its upper portion. In its lower, that is the proximal portion, it was of normal appearance. The subclavian was then tied off and the innominate vein removed after ligation at its normal portion. The specimen was a section of the innominate vein one and one-half to two inches long which showed on gross examination a thickened wall but no thrombus.

Microscopical examination revealed a typical phlebitis of the innominate vein without thrombosis. It terminated well within the limits of the specimen. The clinical course after operation was that of sustained fever for three weeks and death. Blood cultures after excision of the innominate vein were negative. A sacral abscess at the site of pressure necrosis was incised. The signs of meningeal irritation continued. No metastatic foci could be discerned. Death appeared to be due to a continuing cerebral focus rather than to septicæmia.

At autopsy the distal portion of the lateral sinus was bound down to the surrounding tissues in one thrombotic mass with obvious evidence of surrounding inflammation. The meninges were dulled and the ventricles were somewhat distended. The cerebral lesion was interpreted as a productive (toxic) meningo-encephalitis. This appeared to be the cause of death. The stump of the innominate vein was healed and there was no evidence of phlebitis in the remaining portion. In this case septicæmia was not controlled by evacuation of the thrombus in the lateral sinus and excision of the jugular vein, but was definitively controlled after excision of the innominate vein beyond the limit of phlebitis.

SUMMARY.—Pyogenic phlebitis derived from a regional infective focus is a frequent source of general septic invasion (surgical septicæmia).

When phlebitis occurs, the main venous trunk draining the infective focus is usually and obviously involved.

The classical clinical manifestations of septicæmia derived from pyogenic phlebitis are not always present and do not necessarily characterize the severest cases.

There is no definite relationship between the clinical course and the type and degree of phlebitis.

Various forms of phlebitis are described. For clinical purposes they can be grouped into acute phlebitis without thrombosis and acute thrombophlebitis, the latter being more frequently encountered.

The results obtained by attempts at operative control of phlebitis of the lateral sinus can at least be matched in general surgical fields, but the effort is rarely made.

Special attention should be given to the early diagnosis and operative control of phlebitis secondary to infective foci in adjacent soft parts.

Barring some specified contra-indications, exploratory operation should be performed when phlebitis is diagnosed or seriously suspected as the source of general septic invasion.

Excision of the infected vein, beyond the visible limits of phlebitis whenever feasible, is advocated as the operation to be performed. This procedure is a precise one when thrombophlebitis exists, but probably requires modification in the presence of phlebitis without thrombosis.

The technic of operation is based essentially on full exposure of the lesion in the vein.

The best results can be anticipated with early diagnosis and operation but results can also be obtained when an advanced phlebitis and metastatic foci exist.

MULTIPLE MYELOMA SIMULATING HYPERPARATHYROIDISM *

BY HAROLD D. CAYLOR, M.D., AND ALLEN C. NICKEL, M.D.

OF BLUFFTON, IND.

WE WISH to present data concerning a patient afflicted with multiple myeloma which in many respects simulated hyperparathyroidism. The correct diagnosis was made after biopsy with microscopical examination of tissue.

Multiple myeloma is a neoplastic disorder of unknown etiology. Approximately 60 per cent. of the cases occur between forty and sixty years of age.¹ The significant clinical findings in multiple myeloma usually consist of pain occurring at irregular intervals, bone tenderness, generalized weakness and secondary anæmia. Bence-Jones protein has been found in the urine in less than half the cases of myeloma¹¹ and it may be continuous or periodic and in scanty or large amounts. Bence-Jones proteinuria may also occur in myxœdema, leucæmia and carcinoma.³ Recurring fever has been observed with myeloma, although the temperature is usually normal.³ Pathological fracture may occur in later stages of this disease.

The significant röntgenological findings in multiple myeloma are multiple punched-out and mottled areas in the bone, without distortion of the cortex, particularly in the spine, ribs, skull, sternum, clavicle and pelvis.²

Histological study of multiple myelomas usually reveal them as one of two types, although frequently both types of cells may be present. The larger group is the so-called plasma-cell type which is composed in large part of cells resembling plasma cells.³ The other group is the myelocyte type² composed for the most part of cells resembling myelocytes. Some observers consider the latter group as more malignant than the former.

Hyperparathyroidism as a disease entity is a recent exploit in medicine. Erdheim apparently was the first to attempt to associate osteitis fibrosis cystica with parathyroid tumor and to Mandl (Vienna, 1926) belongs credit for the first successful parathyroidectomy.⁸ Gold's successful case followed two years later. Then in rapid order the disease entity was established, through publications by European and American observers. This chronological development has been shown admirably in the excellent study by Donald Hunter.⁸

The common symptoms and findings in hyperparathyroidism are progressive weakness, muscle, joint and vague bone pains and attacks of abdominal pain and vomiting, with secondary anæmia, weight loss, polydipsia and polyuria.¹²

The significant blood findings consist of hypercalcæmia and hypophosphatæmia.¹² The urine contains an abnormal amount of calcium due to a negative calcium balance. There is a marked diffuse rarefaction of the bones

* Presented before the Association of Residents and Ex-residents of The Mayo Clinic, Rochester, Minnesota, October 13, 1932.

as evidenced by röntgenograms; and multiple cysts and tumors of bone are frequently encountered.⁸

CASE REPORT.—A farmer's wife, aged fifty-two years, came to us because of extreme generalized weakness and pains in her left side. Her past history was essentially negative except for a severe attack of influenza in 1918, and a nervous breakdown in 1923. Early in January, 1932, she became almost bedridden because of marked weakness and abdominal distress. One of our group (Dr. C. E. Caylor) saw her at her home and brought her to the hospital for examination and observation.

Physical examination revealed a talkative, bedridden woman, not acutely ill, able to move her head from side to side but unable to raise it from the pillow. She was unable to move quickly and had marked generalized muscular weakness. In rising from a prone to sitting position she had to get up sideways and "climb up on her knees," as it were, in much the same manner as a patient afflicted with progressive muscular dystrophy. Furthermore, gentle but firm pressure also caused pains of the muscles in various parts of the body. There was



FIG. 1.

FIG. 1.—Röntgenogram of pelvis illustrating the areas of rarefaction most marked in the right femur and pelvic bones.



FIG. 2.

FIG. 2.—Röntgenogram illustrating areas of rarefaction in the skull.

marked tenderness along the left lower costal margin which extended back to the costo-vertebral angle. The heart was not enlarged, there was a soft systolic murmur heard loudest in the second and third left interspace, and not transmitted. The laboratory findings were as follows: The hæmoglobin was 83 per cent., red count 4.07 million, white count 5,900. The blood-pressure was 130/76. The urine was essentially negative. The Kline was negative. An electrocardiograph revealed a sinus tachycardia with marked left ventricular preponderance, and an R-T interval of 0.24 second (measured from beginning of the R wave to the crest of the T wave, apparently as measured by Spaulding¹¹). The gall-bladder functioned normally (Graham-Cole method). The basal metabolism rate was 0.

Because of this constant pain radiating to the back and this marked muscle pain, a röntgenogram of the back was taken. In this picture, the spine and ribs revealed an osteoporosis with numerous round to oval shaped rarefactions. In view of this unexpected finding, röntgenograms were taken of the head, long bones, pelvis and hands.

MULTIPLE MYELOMA

(Figs. 1 and 2.) All of these bones revealed a similar picture, with the lesions most marked in the vertebra, ribs, skull and pelvis. These findings demanded a differential diagnosis with special consideration of multiple myeloma, hyperparathyroidism, osteomalacia and metastatic carcinoma. The following table reveals the various blood-calcium and phosphorus levels:

TABLE I

| Date | Blood Calcium | Blood Phosphorus |
|-----------|---------------|------------------|
| 2/ 6/1932 | 8.5 | |
| 2/11/1932 | 15.0 | 3.5 |
| 2/15/1932 | 11.5 | 3.5 |
| 2/16/1932 | 15.0 | 3.5 |
| 2/17/1932 | 13.0 | 3.5 |
| 2/20/1932 | 19.5 | 3.5 |
| 2/29/1932 | 10.0 | 3.0 |
| 3/ 2/1932 | 11.5 | 4.0 |
| 3/ 4/1932 | 15.0 | 3.5 |
| 3/ 8/1932 | 15.0 | 3.5 |
| 3/22/1932 | 11.0 | 3.5 |
| 4/14/1932 | 11.5 | 3.5 |
| 5/30/1932 | 8.0 | 3.5 |

Since the röntgenographical and the first blood-calcium finding were suggestive of osteomalacia, as well as multiple myeloma, the patient was given increasing amounts of quartz light therapy plus viosterol and calcium lactate, for two and one-half weeks with no clinical improvement. A second blood-calcium determination shortly after this treatment was started revealed a high blood calcium. Evidently the first determination of blood calcium (using a different method) was not satisfactory since the blood calcium remained high for six to eight weeks after discontinuing the use of calcium lactate and viosterol.

The diagnosis was finally "simmered" down to one of the two conditions, either hyperparathyroidism or multiple myeloma. A careful examination of the neck revealed no palpable enlargement in the region of the thyroid gland. A biopsy was decided on and the right twelfth rib removed. (February 27, 1932.) Microscopical sections revealed a multiple myeloma of the plasma-cell type. (Fig. 3.)

The question now arose as to whether multiple myeloma and hyperparathyroidism could coexist. The patient was put on a low calcium diet and revealed a negative calcium balance. This finding, associated with the osteoporosis and other findings made us still think of hyperparathyroidism. However, in view of the definite diagnosis of multiple myeloma, a course of deep Röntgen-ray therapy in dosage similar to that used by The Mayo Clinic was given without much noticeable improvement. Some weeks later, March, 1932, the patient improved, and her blood calcium at that time was somewhat lower. (See table.) Whether it was the Röntgen therapy or lowered calcium intake that caused the drop in serum calcium was not demonstrable.

After multiple myeloma was diagnosed, and deep Röntgen-ray therapy was given, the patient was returned to the care of her local physician. Shortly afterward she lost all the gain she had made and further calcium restriction did not help, neither was she in a condition suitable for further X-ray treatment. Consequently, it also was deemed inadvisable to explore the thyroid region. The patient was given symptomatic treatment but progressively grew worse until she was completely helpless, and died four and one-half months after the diagnosis of multiple myeloma was made. Necropsy (limited to neck) revealed no abnormal change of the thyroid or parathyroid glands.

DISCUSSION.—This case was very instructive since it contained findings suggestive of hyperparathyroidism. Even though some of the röntgenographical findings appeared typical for multiple myeloma, they also resembled some of the published röntgenographical findings of hyperparathyroidism and osteomalacia.⁸ Again, the absence of albuminuria complicated the diagnosis. Even though its absence did not eliminate multiple myeloma, it made hyperparathyroidism seem probable.

The normal blood serum calcium value is 9.96 milligrams per 100 cubic centimetres of blood serum with a standard deviation of 0.69 milligram.¹³ The presence of a high blood calcium in this case seemed indicative of hyperparathyroidism, and this view was strengthened by what seemed to be a negative calcium balance which also is a characteristic of hyperparathyroidism.

The available data concerning the blood-calcium values in multiple myeloma is very meagre while the published reports of blood-calcium values in

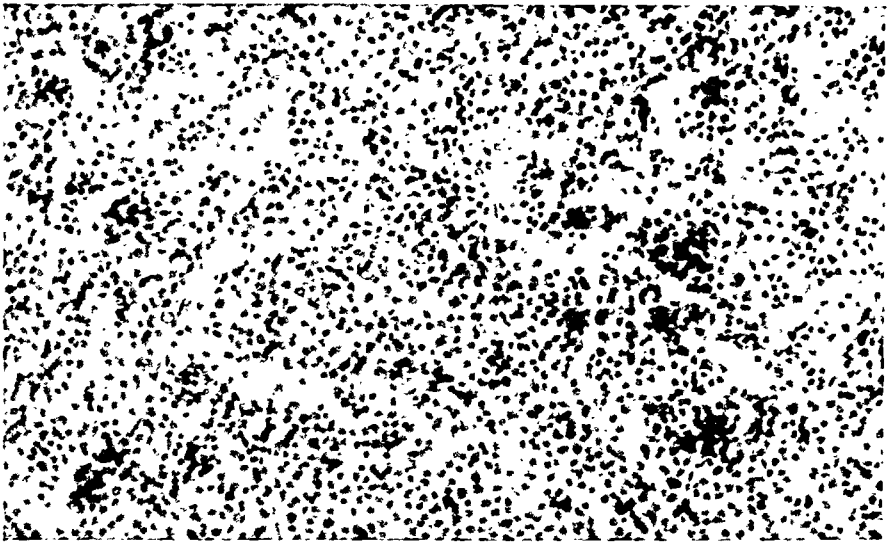


FIG. 3.—Section of tumor tissue removed from right rib. Note the numerous plasma cells with lack of stroma. (x 170.)

other malignant diseases almost invariably point to values either within or below the normal range. Clowes and Frisbe¹ found blood-calcium values very low in actively growing malignant tissue. Goldzieher⁵ reported low values for serum calcium in carcinoma and other malignant tumors; while Ellice McDonald¹⁰ said carcinoma was a disease associated with a lessened amount of total and ionized calcium in the blood. Gunther and Greenberg⁶ found that about 50 per cent. of their cases had a serum calcium definitely below normal and none were above 10.5. They concluded that "the diffusible calcium is within the limits of normal variation in malignant disease." C. de Fermo⁴ also found a lowered serum calcium in malignant diseases. On the other hand, Mason and Shields⁹ reported a case of metastatic carcinoma which had a hypercalcaemia.

There are other diseases in which the blood calcium has been studied. Exophthalmic goitre and myelogenous leucæmias have an increased serum

MULTIPLE MYELOMA

calcium. Lymphatic leucæmia and myxœdema have a lowered serum calcium, while the serum calcium in allergic diseases is within the normal range.

Our consideration of hyperparathyroidism in this case paralleled that of Mason and Shields, who felt that, even though there was a possibility of metastatic carcinoma, the high blood calcium was indicative of hyperparathyroidism. However, in our case, we did not explore the parathyroid region.

In retrospect, there seems to be one vital point overlooked by Mason and Shields as well as by ourselves. In both instances there was a high blood calcium and a negative calcium balance, but the blood phosphorus consistently was normal instead of low. This finding evidently is almost as important in the diagnosis of hyperparathyroidism as is the high calcium content, since by far the greatest number of the proven cases of hyperparathyroidism had a low blood-phosphorus content.

CONCLUSIONS.—(1) Occasionally neoplastic diseases may be associated with a hypercalcæmia although, in general, hypocalcæmia is the rule.

(2) Our observation, and those of Mason and Shields suggest that when a hypercalcæmia and malignant disease, coexist, the blood serum phosphorus content is within the normal limits.

(3) From our study it would seem that the blood serum phosphorus content in hyperparathyroidism is of equal importance with the calcium content.

BIBLIOGRAPHY

- ¹ Clowes, G. H. A., and Frishie, W. S.: On the Relationship between the Rate of Growth Age and Potassium and Calcium Content of Mouse Tumors. *Am. Jour. Physiol.*, vol. xiv, p. 173, 1905.
- ² Coley, W. B.: Multiple Myeloma. *ANNALS OF SURGERY*, vol. xciii, pp. 77-89, 1931.
- ³ Ewing, James: *Neoplastic Diseases*. Third Edition, p. 322. W. B. Saunders & Co., Philadelphia, 1928.
- ⁴ de Fermo, C.: Blood Calcium in Forty-six Cancer Patients. *Minerva Med.*, vol. i, pp. 864-867, 1930.
- ⁵ Goldzieher, M.: Experimentelle Bertrage zur biblogie der geschwiidste. *Verhand J. deutsch, Gesellsch f. Chir.*, vol. xv, p. 283, 1912.
- ⁶ Gunther, L., and Greenberg, D. M.: The Diffusible Calcium and the Proteins of the Blood Serum in Malignant Disease. *Arch. Int. Med.*, vol. xlvi, pp. 67-71, July, 1930.
- ⁷ Hanson, V. S.: Multiple Myeloma. *Jour. Am. Med. Assn.*, vol. lxxix, pp. 2059-2061, 1922.
- ⁸ Hunter, Donald: Hyperparathyroidism. *Brit. Jour. Surg.*, vol. xix, pp. 208-284, 1931.
- ⁹ Mason, R. L., and Shields, Warren: Metastatic Carcinoma Simulating Hyperparathyroidism. *Am. Jour. Path.*, vol. vii, pp. 415-421, 1931.
- ¹⁰ McDonald, Ellice: Abstract from *Jour. Am. Med. Assn.*, vol. lxxxix, p. 824, September, 1927.
- ¹¹ Meyerding, H. W.: Multiple Myeloma. *Coll. Papers Mayo Clinic*, vol. xvi, pp. 880-887, 1924.
- ¹² Pemberton, J. de J., and Geddie, K. B.: Hyperparathyroidism. *ANNALS OF SURGERY*, vol. xvii, pp. 202-211, 1930.
- ¹³ Snell, A. M.: The Diffusibility of the Calcium in the Blood Serum under Normal and Pathological Conditions. *Proceedings of the Staff Meeting of the Mayo Clinic*, vol. v, pp. 17-20, January, 1931.
- ¹⁴ Spaulding, E. D.: Quoted by Max Ballin. *ANNALS OF SURGERY*, vol. xcvi, pp. 649-665, 1932.

ANOMALY OF THE INFERIOR LARYNGEAL NERVE

BY GEORGE DEE WILLIAMS, M.D.

OF ST. LOUIS, MO.

FROM THE DEPARTMENT OF ANATOMY OF THE WASHINGTON UNIVERSITY

ANOMALOUS origin of the right subclavian artery from the descending aorta rather than from the innominate artery has been described by numerous writers. The correlative anomaly of the right inferior laryngeal nerve has also been frequently noted: in which that branch of the vagus nerve has no portion which can be designated by the term recurrent laryngeal, and

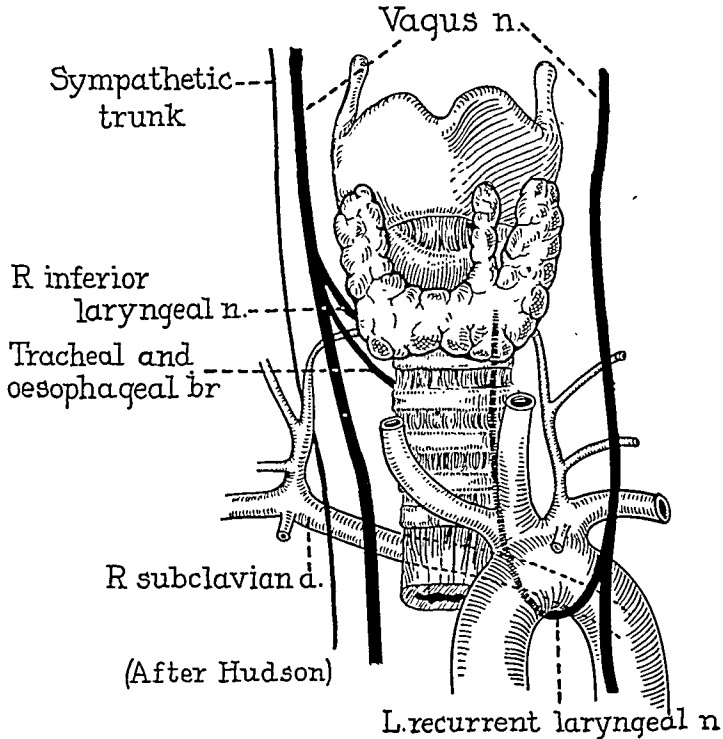


FIG. 1.—Diagrammatic drawing of a case of anomalous origin of the right subclavian artery together with absence of a right recurrent laryngeal nerve. The right inferior laryngeal nerve proceeds directly from the vagus to its distribution. (After Hudson, 1921.)

because it does not recur around the anomalous subclavian artery. It is the purpose of this article to point out the incidence of these related anomalies and to call attention to their possible clinical significance.

The literature on both anomalies was exhaustively reviewed by Holzapfel² (1899). His earliest reference to the anomaly of the right recurrent laryngeal nerve is the report of Stedman⁵ (1823). Holzapfel found that of thirty-five descriptions of the arterial anomaly, three showed the nerve as looping around the anomalous artery; four others exhibited recurrence of the nerve around the right vertebral artery, which in these cases was a

INFERIOR LARYNGEAL NERVE ANOMALY

branch of the right common carotid; the remaining twenty-eight reports (and all others found by the writer in the more recent literature) describe the nerve as originating from the vagus at the laryngeal level and passing directly medially behind the common carotid artery to the larynx.

In surgery of the neck, and especially of the thyroid gland, the inferior laryngeal nerve is sometimes accidentally injured. If the nerve is not in its expected position, it is more than ordinarily liable to injury. Fig. 1 is a diagrammatic representation of the associated anomalies here described. It was drawn from a museum specimen of a case discovered in this laboratory and described by Hudson,³ in 1921. The nerve of the left side shows the normal relations for that side, but the right inferior laryngeal nerve is seen to leave the vagus near the level of the cricoid cartilage and to turn directly medially in close relation to the inferior thyroid artery at its medial bend.

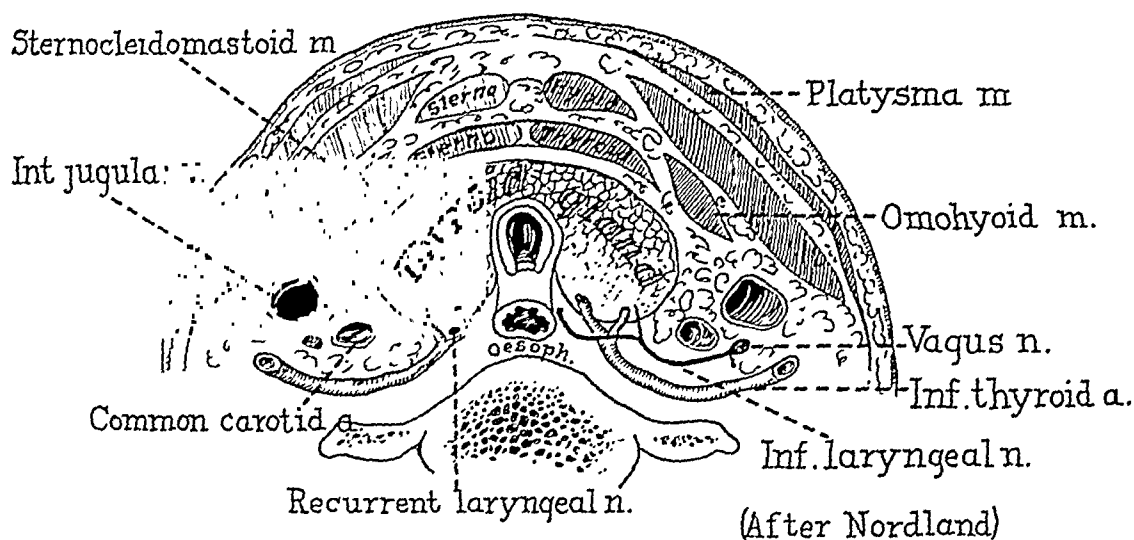


FIG. 2.—Diagrammatic drawing of cross-section of the neck in Hudson's (1921) case of absence of a right recurrent laryngeal nerve. The right inferior laryngeal nerve originates from the vagus at the level of the section and accompanies the inferior thyroid artery to the posterior portion of the thyroid gland on its way to the larynx. (Adapted from Nordland, 1930.)

The possibility of injury to the nerve in its exposed and unexpected position and in its unusual relation to other structures is obvious. The contrast between the normal and abnormal relations of the nerve may also easily be seen in Fig. 2, a cross-section drawing adapted from Nordland⁴ (1931).

The writer⁶ and others (1932) examined 159 aortic arches (seventy-two of white males, fifty-six of Negro males, twenty-three of Negro females, and eight of white females) and found four anomalous right subclavian origins. One case occurred in each of the four race-sex groups. The percentage incidence of the arterial anomaly in the author's total series is therefore 2.6 per cent. Other authors (quoted from Adachi,¹ 1928) have reported percentage incidence as follows: Quain, 0.4; Turner, 0.4; Lehoucq, 0.5; Holz-apfel, 0.6; Stieda, 0.8; Tiedemann, 0.8; Thomson, 1.0; Hyrtl, 2.0; Adachi (for Japanese), 0.2. Adachi suggests that the anomaly of the right subclavian artery is commoner in Negroes than in other races, and quotes several examples in Negro females. The incidence for the author's white males is 1.4 per cent.; for Negro males, 1.8 per cent.; for Negro females,

1 in 23, or 4.3 per cent.; for white females, 1 in 8. One is hardly justified in stressing percentage incidence in such small series as the two latter.

The point of this article is not to define the exact incidence of these associated anomalies. It is rather more important to suggest that the surgeon may encounter one or more of these cases in every series of 100 thyroid operations that he performs. It is also possible that the presence of these anomalies may account, at least in part, for unexplained post-operative symptoms of injury to the inferior laryngeal nerve.

BIBLIOGRAPHY

- ¹ Adachi, Buntaro: *Das Arteriensystem der Japaner*. Bd. i, pp. 35-40, 1928.
- ² Holzapfel, Gotthold: *Ungewöhnlicher Ursprung und Verlauf der Arteria Subclavia Dextra*. *Anatomische Hefte*, i Abt., Bd. xii, p. 369, 1899.
- ³ Hudson, W. A.: *A Case of an Anomalous Right Subclavian Artery*. *Washington University Studies*, vol. ix, scientific ser., No. 1, p. 219, 1921.
- ⁴ Nordland, Martin: *The Larynx as Related to Surgery of the Thyroid*. Based on an Anatomical Study. *Surg., Gynec., and Obst.*, vol. li, p. 449, 1930.
- ⁵ Stedman, G. W.: *A Singular Distribution of Some of the Nerves and Arteries in the Neck and the Top of the Thorax*. *Edinburgh Med. and Surg. Jour.*, vol. xix, p. 564, 1823.
- ⁶ Williams, G. D., Aff, H. M., Schmeckebeier, M., Edmonds, H. W., and Graul, E. G.: *Variations in the Arrangement of the Branches Arising from the Aortic Arch in American Whites and Negroes*. *The Anatomical Record*, vol. liv, No. 2, 1932.

AMOUNT OF GLAND TO BE LEFT AT THYROIDECTOMY

By ADDISON G. BRENIZER, M.D.

OF CHARLOTTE, N. C.

THE two questions most frequently asked: "What causes a goitre?" and "If the goitre is removed, will it come back?" can be answered rather vaguely in the first instance, but satisfactorily enough in the second instance. The two questions, however, are linked together, for the known circumstances under which goitre occurs, if allowed to persist, may bring about a recurrence regardless of how little gland is left behind at operation. Though



FIG. 1.—The head is turned to the right side, bringing out the configuration of the sternomastoid muscle. A line from the tip of the mastoid process to the mid-point of the clavicle bounds the posterior border of this muscle and the mid-point of this line or a line intersecting with it from the upper border of the thyroid cartilage is opposite the transverse process of the four cervical vertebra. The needle point is pushed in to the bone, from right to left with an inclination backward and ten cubic centimetres of novocaine 1 per cent. are injected as the needle is slowly withdrawn.

the cause of goitre is not known, certain circumstances under which it occurs are definitely recognized and a more satisfactory statement can be given than a dictionary definition, as: "Goitre is a disease of unknown cause, the most common characteristics of which are disturbed function and enlargement of the thyroid gland."

In a series of over 2,500 thyroidectomies, (1) 2,238 were women and women frequently with a hypo-ovaria; (2) there was a shortage on iodine, as proven by the benefit of administering iodine in a large number of the

1,482 cases of exophthalmic goitre and in some of the 1,018 cases of adenomata, simple goitre and thyroiditis; (3) there was a focus of infection suggested by the improvement in the thyrotoxæmia by the removal of a definite focus and the hyperplasia actually accompanying a thyroiditis; (4) there was a relation with other endocrine glands, particularly the adrenal, as suggested by usually high systolic and pulse pressures and the exaggeration of symptoms on giving epinephrine; with the pancreas, suggested by the disturbed carbohydrate metabolism; (5) there was a thyro-thymic-lymphatic constitution, the familial tendency in exophthalmic goitre and the proneness to recurrences; (6) there was mental and physical overload, the larger proportion of men during the war and during this depression.



FIG. 2.—The second point of injection is made about an inch below the tip of the mastoid process, on the level of the angle of the mandible and the posterior border of the sternomastoid muscle. This point is about opposite the transverse process of the second or third cervical vertebra.

There are many contributions and a revival of these contributions recently on the subject of how much of the thyroid gland should be removed. (Pemberton, McClure, Lahey.) The question of importance is not how much goitrous gland can be sacrificed, but how much should be spared, or what minimum amount of gland left behind can eventually and permanently stabilize the thyrotoxic patient and sustain, as near as normal, a satisfactory metabolism.

Certainly and without argument, the more of the thyrotoxic gland removed or the less left behind, the more immediate and permanent relief of the thyrotoxæmia. On the other hand, some gland, though a minimum amount, must be left behind in the presence of the most intense thyro-

POST-THYROIDECTOMY GLAND RESIDUE

toxæmia to surely protect the parathyroids glandules and recurrent laryngeal nerves and forestall a hypothyroidism. At the first operation a sufficient amount of gland must be removed, not only to surely reduce the thyrotoxæmia, but to protect, so far as possible, against a second or third operation. Theoretically, at least, every operation offers still further chances of injury to the parathyroids and recurrent laryngeal nerves; forty-seven of our total series had been operated on elsewhere and were reoperated on by us on account of persistent or recurrent thyrotoxæmia, and thirteen of our own cases were subjected to sixteen second and third operations and demanded these operations as much at the second and third times as at the time of the original operation.



FIG. 3.—The top needle inserted an inch below the tip of the mastoid and on the level of the angle of the jaw, reaches the bony resistance near the transverse process of the second and third and the lower needle near the fourth and fifth transverse process of the cervical vertebra. One injection of ten cubic centimetres at this point on each side, without any further infiltration, has sufficed for a perfect anæsthesia.

One patient operated on three times still has a metabolic rate of plus. 24. A larger amount of tissue should be left behind in all cases of thyroiditis accompanied by thyrotoxæmia, because the final result of the inflammatory process is the destruction of the gland and a hypothyroidism. The reasons that thyroiditis is operated on at all are: (1) To drain an abscess or to liberate the adherent and hardened condition of the gland itself and the structures in the neck, as for example, following a cellulitis and in Riedl struma and Graham's struma lymphomatosa—the resection of the isthmus, as

well, in the relief of Riedl struma may not only relieve the hampered trachea but the whole liberation may improve the blood supply of the gland itself from the surrounding tissue; (2) To lessen thyrotoxæmia, particularly in the diffuse tuberculous type, accompanied by thyrotoxæmia; (3) On account of wrong diagnosis the Riedl struma is operated on for carcinoma, or the thyroid gland found diffused with tubercles, and accompanied by hypertrophic and hyperplastic cells.

The amount of goitrous gland removed is not to be judged by bulk, for there are cases improved in the way of increased secretion by the removal of bulky non-toxic adenomata which have crowded out the secreting portion of the gland, crowding even the parathyroids.

Pemberton¹ is quite right in two of his statements: "The high proportion of patients who are entirely and permanently relieved of their symptoms by subtotal thyroidectomy, in which a varying amount of thyroid tissue is left, is sufficient clinical evidence to indi-



FIG. 4.



FIG. 5.

FIG. 4.—The lateral points are connected with injections under the skin along the line of the projected collar incision, while waiting for the nerves of the cervical plexus to "take up" the novocaine.
FIG. 5.—Outline of the sternomastoid muscle and the short collar incision, c—c. The additional length of incision B—c is not needed. a and B are the horizontal levels at which injections are made.

cate that the remaining portion of the gland regains its power of regulating its function to meet varying demands," and, "as long as there is any viable thyroid tissue, even though (temporarily) functionally inadequate, to meet the normal demands of the body, it is capable, under proper stimulus, of regenerating even to the point of causing hyperthyroidism." He cites two cases of myxœdema, following thyroidectomy, where marked thyrotoxæmia recurred and one of the cases required a second operation. When the factors or circumstances under which thyrotoxæmia has originally developed are allowed to persist, any case may recur more than once. The most difficult factors to combat are the unalterable hereditary disposition, particularly in the woman with a hypo-ovaria, born predisposed and ever inclined to a recurrence.

I heard Pemberton,² in a recent paper, state that his proportion of women to men was 2:1 instead of 10:1, as reported in my series. During the war and now during the depression, my rate of men to women has risen markedly, now about 5:1 women to men. During these years of financial depression, when men driven into frenzy by disruption of their business, money losses and extreme despair, when many have committed suicide, gotten drunk for liberation and have stirred the gland of emotions, the thyroid, to over activity, the exophthalmic goitre group of men has increased. I saw just such conditions

POST-THYROIDECTOMY GLAND RESIDUE

among the men with thyro-toxic tendency during the war: effort syndrome, shell shock, thyro-toxemia. The postponement of operation has offered cases far more severe burnt out from delay and the mortality consequently increased during the last two years, due to these factors, and in addition, a more precipitous attitude in selecting these cases, influenced, perhaps, by a too ardent desire to put these people back on their feet rapidly and likewise the very human ambition to maintain the number of cases operated on. During this last two years, out of 303 cases, 41 were men, nearly double my former figures. There were also four recurrences.

I have seen people, not of the hyperthyroid tendency, but frenzied by their reversed conditions of living, along with the abrupt changes in "morals and manners," get a certain amount of beneficial liberation from themselves by the use of alcohol, but this liberation would be temporary in effect and produce a next day's weariness and fatigue, almost equal to pain, when called upon to do any exacting piece of work.

The hyperthyroid person suffers a severe "hang-over" from even so-called moderate drinking, an effect far beyond the usual weariness and fatigue, to the point of "Jitters."

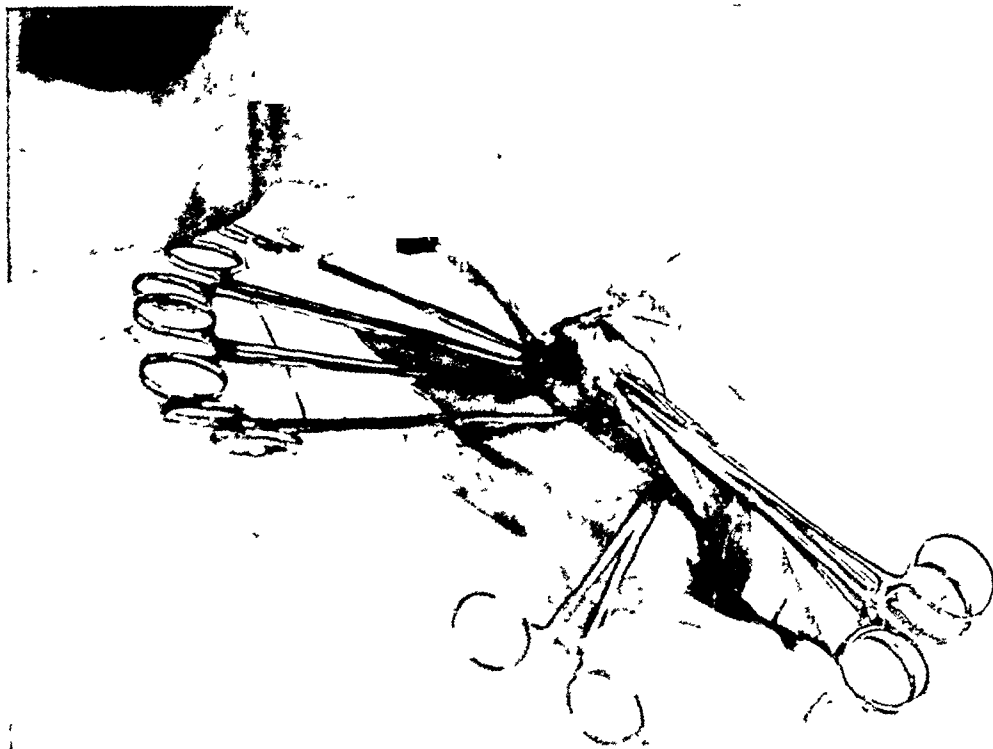


FIG. 6.—Incision down through skin, fat and platysma muscle, fascia of sternohyoid and sternomastoid muscles exposed.

The effects of alcoholism and thyro-toxemia, to the stage of delirium, are in many ways similar.

The standard operation of bilateral resection at The Mayo Clinic embraces the removal of the isthmus, a part of both lobes, preserving on each side of the trachea an amount of gland equivalent to from one-sixth to two-thirds of the amount of tissue in a lobe of normal size. Of 1,683 patients with exophthalmic goitre, fifty (2.9 per cent.) demanded further surgical treatment. Pemberton¹ did not state the proportion of post-operative hyperthyroidism to hypothyroidism.

Out of a total group of 1,270 goitre operations, McClure² reported forty (3.2 per cent.) cases with post-operative hypothyroidism and fifteen cases (1.2 per cent.) of post-operative hyperthyroidism. He does not state the original number with thyro-toxæmia of the Graves' type. His post-operative results were 3 to 1, hypothyroidism over hyperthyroidism. His operation is more radical than the standardized operation at The Mayo Clinic.

Lahey⁴ does not give figures and proportions of number of post-operative hyper-

thyroidism to hypothyroidism, but indirectly, with the exception of children in the pre-adolescent and adolescent period, elderly patients, marked involution after iodine administration and multiple adenomata, all of which are embraced in our statement that the amount of tissue left behind is to be judged more by the pre-operative thyrotoxæmia and metabolic rate, rather than the bulk of the gland, we have included these exceptions in our general statement. On the other hand, in the same types of cases we are speaking about, those with intense thyrotoxæmia, he does about the same radical operations as we do. Quoting Lahey: "Complete removal of the thyroid isthmus, with premeditative baring of the trachea and this baring of the trachea does not produce any disturbing amount of post-operative tracheitis, and with extensive removal of thyroid tissue from the lateral lobes of the thyroid leaves a safe amount of tissue over the recurrent laryngeal nerves and the parathyroid bodies and makes possible the radical removal of the thyroid tissue that is often necessary to bring about lasting cures in hyperthyroidism."



FIG. 7.—Transverse incision retracted vertically. Incision vertically between sternohyoid and sternothyroid muscles, separation between deep cervical fascia, false capsule, and thyroid gland, true capsule. Muscles well relaxed, widely retracted, gland exposed.

Greene⁶ has operated on twenty-six children between eight and sixteen years out of a series of 1,200 thyroidectomies. He thinks little of the precaution of preliminary ligation or chances of hypothyroidism during the growing period except more gland should be left behind. Still, he had two recurrences out of twenty-six cases.

Coller and Arn⁶ conclude: "A large part of a nodular goitre can be removed from a patient with a basal metabolic rate in the low limits of normal without importantly affecting the rate."

The large majority of this series of 2,500 thyroidectomies was done on account of the thyrotoxic state. Lobectomies or sub-total thyroidectomy in 1,482 cases of exophthalmic goitre; enucleations, unilateral and bilateral resections and dissection in 1,018 adenomata, cysts, simple goitre and thyroiditis.

Females predominated in the proportion of 2,238 to 262 males; ten children, all females.

POST-THYROIDECTOMY GLAND RESIDUE

Death occurred in twelve cases, ten of exophthalmic goitre and two of adenomata. There were three late deaths in cases of recurrent carcinoma, which has made up about 1 per cent. of the group of 1,018 cases.

There were forty-seven cases operated on elsewhere in the whole series of 2,500, requiring a second operation by us. Of the 2,500 cases operated on by us, thirteen cases, ten of exophthalmic goitre and three of adenomata, have required reoperation, and three of these were reoperated on twice on account of hyperthyroidism. The metabolic rate in all of these cases was above plus 30.

We have found but three cases of permanent hypothyroidism following all operations for exophthalmic goitre and toxic adenomata and certainly

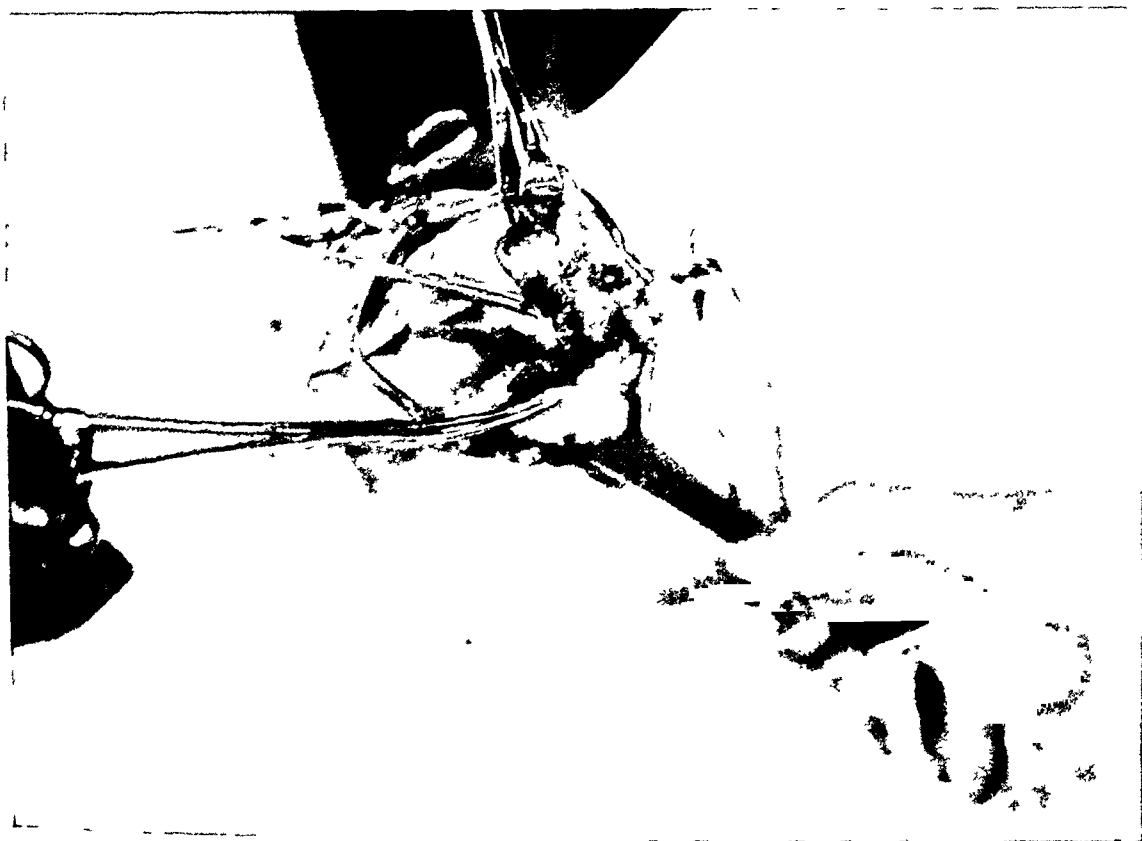


FIG. 8.—Isthmus bluntly elevated from trachea, split or resected, right lobe undercut from trachea and held up with lobe clamp. Left lobe held with curved clamp.

no case of myxœdema. There have been, however, a number of cases of transitory hypothyroidism which have finally stabilized by withdrawal of post-operative iodine administration or the taking of thyroid extract over a short period of time. There has been one death from severe and persistent hypoparathyroidism and tetany, and three cases who showed mild transitory symptoms of hypoparathyroidism, and, strange to say, the case of tetany and death was an adenoma where it would hardly seem possible to have disturbed the parathyroids. There were no voice changes but a typical accoucheur's hand contraction on the table. There is no case of permanent aphonia. There are, however, four cases with altered voices and lameness or paralysis of one vocal cord.

In the thirteen cases where second or third operations were done and

three operated on twice, making sixteen second or third operations on thirteen cases, all but one has returned to a satisfactory state of thyroid stabilization, judged by clinical symptoms and metabolic rate. There is no evidence of hypothyroidism, nor hypoparathyroidism, nor alteration of voice after these second and third thyroidectomies. The one case after three thyroidectomies is still mildly hyperthyroid with a metabolic rate of plus 24, but his clinical improvement is satisfactory.

Our operation in cases of exophthalmic goitre for the last fifteen years has been almost invariably as follows: Usual collar-line incision but very short incision, dissection of flaps between platysma and underlying muscles or between fat and platysma,



FIG. 9.—Both lobes undercut and resected leaving strip of thyroid on each side of bared tracheal fascia. Probe touching small portion of right lobe left behind at upper pole before allowing it to sink into depth of neck.

incision up and down between muscles, rarely with transverse cutting, gland exposed. Our dissection is not very wide, only enough to make the gland accessible. The isthmus is bluntly elevated from the trachea, when possible caught with two clamps and cut, leaving the fascia covering the trachea. The two lobes are immediately begun to be undercut, leaving a thin wedge of gland on either side of the trachea. Then working from the lower pole upward, each lobe is raised from its capsule, the superior vessels easily recognized and by still undercutting and elevating, all gland is removed except the wedge-shaped strips along the trachea and continuing into the upper pole, about one-quarter to one-half inch broad and thick. Special attention is paid to the vessels at the lower border of the gland, to those springing from the trachea and the ramifications of the inferior thyroid, clamped separately, close on the gland, on account of the blood supply to the parathyroids. It is remarkable how easily the lateral lobes are raised out of the neck, when the attachments to the trachea are cut and the vessels in the true capsule, all around the periphery, are clamped high on the gland. The operation amounts to an enucleation of almost the whole lateral lobes, each a cone with the small end at the

POST-THYROIDECTOMY GLAND RESIDUE

superior pole. We are forced at times to "take off" at the side of a bulky isthmus or first to resect the isthmus on account of its bulkiness, or, occasionally, to pull the upper pole down. The amount of gland left behind varies from the extreme of a wedge one-quarter to one-half inch wide and thick, depending upon the toxic condition of the patient before operation as judged by the circulation, excretion, nutrition, self-control, basal metabolism and perhaps some such test of breath-holding or general stamina as done by Willard Bartlett.

Not only can an estimate of the general condition of the patient be made during pre-operative preparation, but frequently a difference in the size and texture of the gland itself can be made out as involution takes places. The more readily involution takes place in the gland under preparation with iodine, the softer elastic the gland becomes, though perhaps larger. This change in the gland itself can be recognized at operation by the naked eye. The original hard, granular, friable, very vascular reddish-brown gland has become more pinkish, more glassy and less friable. If involution takes place readily under iodine it is desirable that more of this gland, as well as all glands of the colloidal type, be left behind.

As pointed out by Lahey, it is particularly desirable that sufficient gland be present to meet the demands of adolescence and the abating cellular activity of old age. On the other hand, only a very small amount of the uninvoluted gland, at whatever age, must be left behind to assure stabilization in thyrosusceptible patients. We consider our operations radical in cases which are or have been markedly thyrotoxic, radical for the sure relief of the thyrotoxæmia and the forestalling of reoperation, but of course to no such point of stripping the trachea as done by Richter in Chicago, with his claim that he leaves "just a gram on each side of the trachea." We cannot even visualize just a gram of thyroid gland in the neck.

At the second or third operation, the wedge-shaped strip and portion of the upper pole have been found much enlarged on one or the other, or on both sides, the size of the gland at many primary operations. After separation of the sterno-thyroid muscles from the front of the trachea and gland, mostly by sharp dissection, the lobes are again undercut from the mid-line outward and elevated from the lower pole upward and outward to the upper pole, with difficulty on account of adhesions, but in the same way as at the primary operation. We have but one case of post-operative hyperthyroidism and no other particular disturbance in the post-operative course of these thirteen reoperated-on cases, in spite of the fact that metabolic rates ranged from plus 30 to 65.

At all operations for adenomata, we have inspected, palpated and even incised every portion of the gland left behind for additional smaller adenomata, and, in spite of this diligent search, have had three cases of growth of an adenoma evidently left behind, while in process of growth from a small focus. On one of these we operated three times, at each time removing additional adenomata. This was not carcinoma as we first feared, and proved not to be by pathological section and confirmed by the fact that the man is living and in good health eight years since the last operation. These

cases of adenomata were not reoperated on because of recurrent masses in the neck, but on account of elevation of metabolic rates from plus 30.

It is made clear from the above report and description of operation that the number of cases of both recurrent hyperthyroidism and hypothyroidism have been comparatively few, that the chances of hyperthyroidism are about four to one over hypothyroidism, in spite of the fact that the operation is radical, leaving a minimum quantity of the gland behind. This procedure at first, second and third operation has been safe and has given almost absolute protection to the recurrent laryngeal nerves and parathyroids.

The wedge of gland left along each side of the trachea, by immediately undercutting the lobe and entirely detaching it from the wedge, prevents the necessity of pulling on this important area overlying and protecting the parathyroid glandules and recurrent laryngeal nerves. We have found our own sixteen cases of second and third lobectomies easier to approach than the forty-seven cases requiring a second operation, which were originally operated on elsewhere. In these latter patients, we have found an extreme bulkiness and scarring over the trachea and a large amount of gland particularly in the region of the upper poles. We have found the pad of gland between the trachea and overlying muscles more adherent to muscles than to the bared tracheal fascia and much more bloody in liberating from the muscles. Our closures unite the sternothyroid and sternohyoid muscles separately.

Most of our thyroidectomies drain from twelve to sixteen days, after the removal of small drain tubes in forty-eight hours, and a small skin incision is kept open by the insertion of a probe. We hear little mention of this rather prolonged drainage from other sources in the literature, though the operators tell me about the same experience. Some of the remaining gland is lost through prolonged drainage, particularly when large portions have been ligated or the tissue sewn together in bulk, or when an infection is superimposed.

The least of our trouble has been secondary hæmorrhage, although we not infrequently find considerable blood on our first dressing, in spite of what has appeared to be complete hemostasis at the end of the operation. Where there is apparently a small hematoma, we think it better to let it disorganize and gradually drain away, which it invariably does, rather than re-enter the neck to remove it.

We have been very careful about operating on children and have tried a preliminary ligation in one case followed later by thyroidectomy. Our experience leads us to believe that there is very little to be gained by ligations at any age and that intense thyrotoxæmia must be reduced even in children.

In the preparation of patients for operation, we have observed that the refractoriness to iodine may disappear after a considerable period of freedom from it and that iodine can be given again with benefit. This observation has been particularly true in those of the Graves' type of thyrotoxæmia

which have recurred a year or more after the primary operation. We have been able to smother an occasional toxic crisis, usually post-operative, by the giving, in desperation, of a large quantity of iodine intravenously, and feel that this benefit has been brought about by the qualitative alteration of the thyroid secretion in the blood-stream.

We do not believe that the condition of the patient can be determined by the metabolic rate alone, but rather by the general improvement. Some of our patients, with rather low rates, have reacted violently, whereas those with very high rates, which have been but little reduced under preparation, have shown no reaction after operation. There is evidently a susceptibility of certain patients to thyroid-secretion just as to caffeine and alcohol.

We have had little benefit in treating adenomata with iodine and have usually seen a non-toxic adenoma aroused to activity by the administration of iodine, except in children, with adenomata present at birth or appearing early in childhood. These adenomata in children, though reduced in size and softened by iodine, never disappear. Even in the soft, diffuse, non-toxic goitres of adolescence, iodine has not brought about a reduction in the size of these glands overnight. At least three of these patients have been driven into a thyrotoxæmia of the Graves' type by an excessive and prolonged use of iodine. The diffuse, non-toxic goitre of the colloid variety, possibly embracing adenomatous inclusions in 20 per cent. of cases, occasionally shows the effect on the adenomatous inclusions by an aroused toxicity in the presence of iodine. We have seen adenomata appear in these glands as the surrounding hypertrophied tissue became less bulky.

We think the final thyroid cell, lining the acinus, whether originally appearing in a foetal or adult adenoma, in the diffuse goitre with or without toxæmia, is one and the same cell altered merely in hyperplastic activity and giving rise to a secretion varying in quantity rather than quality.

The thyroid cell, embraced in the capsule of an adenoma of long standing, is far more apt to break its cohesion with other cells and become prolific and mitotic than the cell free in the whole lobe. About 90 per cent. of carcinoma of the thyroid, amounting to about 2 per cent. of all adenomata, occurs in long-standing adenomata. I have never seen but one diffuse carcinoma of a lobe of the thyroid where there was not evidence of a pre-existing encapsulated adenoma. Since an early adeno-carcinoma can be diagnosed only by the piling up of mitotic cells, which have invaded a blood-vessel, the taking on of any acceleration of growth of an existing adenoma should be a warning to operate and remove the adenoma, not by simple enucleation, but by resection or lobectomy, that is, the adenoma with thyroid tissue surrounding it. Adenomata in patients under thirty may be regarded with more complacency and the operation determined on account of the accompanying toxæmia, rather than malignancy. Our experience with adenomata and the age of appearance leads us to believe that they are far more frequent in the young, that is, before thirty years, than a review of the literature would lead one to believe.

Our observations of our own cases in regard to the thyrotoxic state following thyroidectomies has been that of persistent or recurrent hyperthyroidism, 4 to 1, over hypothyroidism, whereas McClure, who does about the same radical operation as we do, cites an incidence of hypothyroidism, 3 to 1, over hyperthyroidism. Pemberton, who does a standardized operation, less radical than McClure³ and I, has had about three times as many recurrences of hyperthyroidism. I judge Lahey's operation as to amount of gland left behind in severely toxic cases of the Graves' type is about the same as that of McClure and me. Pemberton is quite right, however, in his observation that the percentage of recurrence of hyperthyroidism is not to be determined alone by the quantity of gland left behind, and, in proof of his contention, cites three cases of marked hypothyroidism, which eventually again become hyperthyroid.

The same circumstances or factors, namely, a woman, usually with hypovaria, a focus of infection, shortage on iodine, a mental and physical drive, all continuing to play on the predisposed type of individual, may bring about a proliferative hyperplasia and an accompanying thyrotoxæmia, even when a minimum of thyroid cells have been left behind at the original operation. These patients must receive preferably printed instructions as to rest and care of themselves and encouraged to return regularly for observation and advice.

I shall not dwell upon the dual phases of thyrotoxæmia, hyperthyroidism and hyperadrenalism. I shall leave the discussion of the interrelation of the secretions of these two glands entirely to Crile,⁷ until I am aroused to change my tactics on account of less favorable results by operations on the thyroid gland alone. I must admit, on the other hand, a combined hyperadrenalism, after observing the effect of epinephrine on hyperthyroid patients, as well as the usual high systolic and pulse-pressure type of patient with higher metabolic rate and particularly the gastro-intestinal type with vomiting and diarrhœa. I once thought that epinephrine should actually be administered to the exhausted, emaciated type of patient with low blood-pressure, on the assumption of a depleted adrenal gland, particularly since some of these low blood-pressured, even-pigmented patients suggest a combined picture of hyperthyroidism and hypo-adrenalism, Addison's disease, but even these patients are driven to further exhaustion and are acutely aroused by epinephrine.

The scope of this paper and the time limit will allow but a few remarks on the relation of the thyroid and pancreas. I have found an increased blood sugar in hyperthyroid cases, both before and immediately following operation. I have been able to arouse the patient from a somnolent or comatose state by giving insulin or glucose and insulin and have finally seen the blood sugar remain at a normal level. We may certainly feel better fortified in our position before operation by having paid some attention to a blood sugar and blood calcium, as well as to the condition of heart muscle and fibrillation and the function of the vocal cords.

POST-THYROIDECTOMY GLAND RESIDUE

CONCLUSIONS.—(1) Thyrotoxæmia in our series of cases occurs overwhelmingly in the women. The number of men increased during the war and now during the depression. The association is probably a hypo-ovaria. At puberty, menstruation, the menopause and during pregnancy, the thyroid works inversely parallel with the corpus luteum. When the corpus luteum is adequate, there is little or no enlargement of the normal thyroid gland.

(2) Certain factors, namely, the woman, a focus of infection, demand for iodine, seasonal and dietetic effects, mental and physical strain, and a goitre constitution must be considered. Thyroiditis makes up $\frac{1}{2}$ per cent. of operative material and $\frac{1}{4}$ per cent. of all observed clinical cases. Thyrotoxæmia may accompany most types of thyroiditis at any stage, usually the acute or subacute stages.

(3) Iodine is slow in flattening even simple, diffuse, non-toxic goitres of adolescence. Its prolonged and excessive use may bring about a thyrotoxæmia even in these cases. It may arouse a non-toxic adenoma to a fierce activity. It is of marked benefit in thyrotoxæmia of the Graves' type and refractoriness to iodine may be overcome by a period of freedom from iodine.

(4) The prevention of recurrence of proliferation of thyroid tissue and thyrotoxæmia cannot be accomplished by the post-operative administration of iodine, nor by the radical removal of the gland alone, in the presence and persistence of the above factors influencing and exciting thyroid activity. In cases with persistent autonomic symptoms likely related to the "brain" of the autonomic and chromaffin systems, the adrenal gland, a denervation of the adrenals in Crile's hands has stabilized these patients.

BIBLIOGRAPHY

- ¹ Pemberton, John deJ.: Recurring Exophthalmic Goiter. *Jour. Am. Med. Assn.*, May 10, 1930.
- ² Pemberton, John deJ.: Paper on Goiter. Delivered at Greensboro, N. C., December 3, 1931.
- ³ McClure, Roy D.: Post-operative Hypothyroidism. *Western Jour. of Surg., Obst. and Gynec.*, September, 1931.
- ⁴ Lahey, Frank H.: How Much Thyroid Tissue Should Be Removed in Toxic Goitre? *ANNALS OF SURGERY*, vol. xcv, No. 4, April, 1932.
- ⁵ Coller, Frederick A., and Arn, Roy D.: Thyroidectomy for Goiter without Hypothyroidism. *Western Jour. of Surg., Obst. and Gynec.*, July, 1931.
- ⁶ Greene, Earle I.: Thyroidectomy for Thyrotoxicosis in the Young. *Surg. Gynec., and Obst.*, September, 1931.
- ⁷ Crile, George W.: The Interdependence of the Thyroid, Adrenals and Nervous System. *Am. Jour. Surg.*, May, 1929.

SKIN CONSERVATION IN RADICAL MASTECTOMY FOR CARCINOMA

BY LOUIS FRIEDMAN, M.D.

OF NEW YORK, N. Y.

FROM THE DEPARTMENT OF SURGERY OF SYDENHAM HOSPITAL

IT HAS been the custom in radical mastectomy to sacrifice the skin covering the entire breast, leaving in many instances a wide gaping wound often difficult to close. This procedure has been followed more from traditional proscribed teaching and habit than from any reasonable justification. There certainly is no rational reason why the integument covering the side of the breast not containing the tumor mass should be sacrificed. Sections made of the skin and areolar tissue covering the breast outside of the tumor area show no histological changes from the normal. In fact, sections made of the skin and areolar tissue right above the mass when the skin is not adherent show no changes from the normal.

When the skin is yielding and elastic, the wound closure is easy, but in many cases there is great tension, immobilizing that half of the chest, making the patient very uncomfortable, or considerable surface must be left uncovered, which either has to be allowed to granulate or be skin grafted. In many instances, where a large area of skin has been removed, the tension, when wound closure is attempted, is so great that the blood supply of the integument is interfered with, resulting in necrosis, and the scar following healing is ugly, irregular, and has a tendency to spread. Skin recurrence is infrequent and is more likely to occur in scar tissue or skin which has been under tension, and is adherent to the chest-wall. Handley pointed out that Halsted, who laid special stress on wide skin excision, had 16 per cent. of recurrence in the skin, while Cheyne, who removed more fascia than Halsted but less skin, had only 6.5 per cent. of such recurrence.

An ideal breast incision should permit easy access to the axillary space so that thorough removal of axillary lymph-nodes and fat can be accomplished. It should permit closure of wound without undue tension, without the necessity of skin grafting or a granulating area, and should leave a fairly presentable linear scar.

Each of the classical incisions so far devised was to be the ideal one, with the thought in mind that it would cover the wide gaping wound completely without undue tension. All of them, in many instances, failed, only because of the unnecessary sacrifice of normal skin covering the normal part of the breast.

Various methods of skin plastic, flap formation and wide skin under-cutting and mobilization are necessary and resorted to in order to enable wound closure, and even then with considerable tension and difficulty.

All this can be avoided by conserving and utilizing the skin covering the

SKIN CONSERVATION IN MASTECTOMY

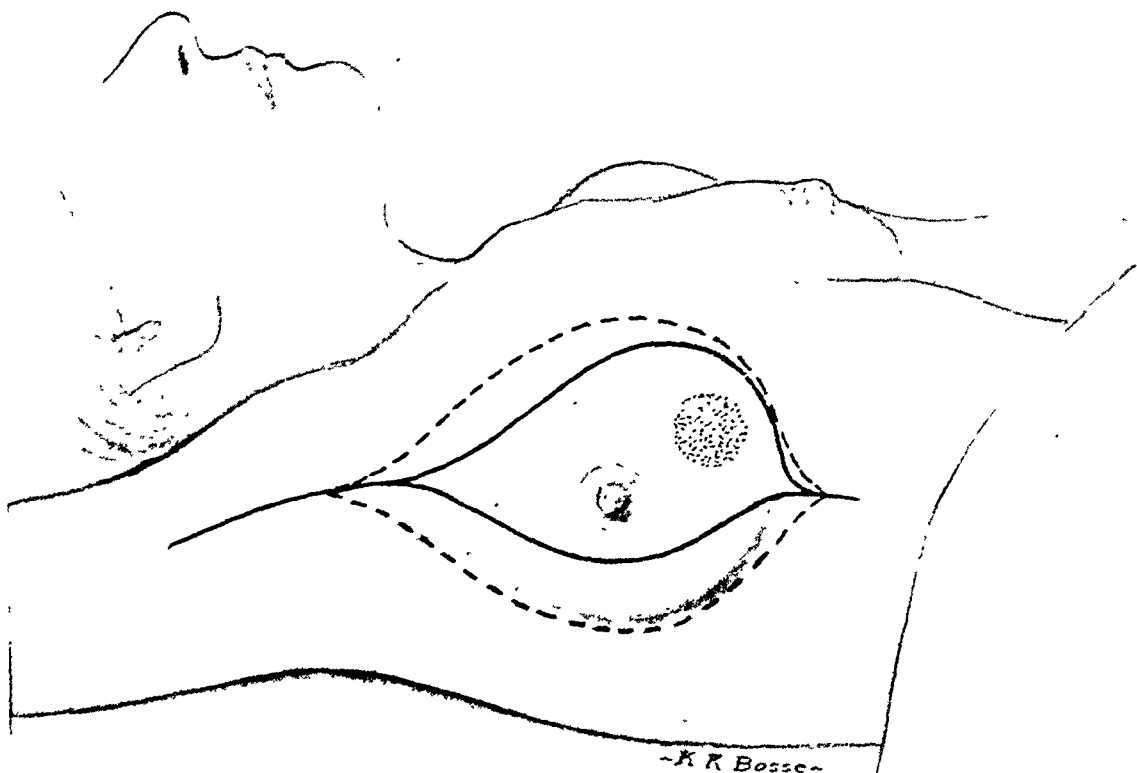


FIG. 1.—Radical breast amputation showing outline of conservative skin incision (black line), with approximate amount of skin saved. Dotted line showing usual incision sacrificing skin covering entire breast. Tumor in left lower quadrant.

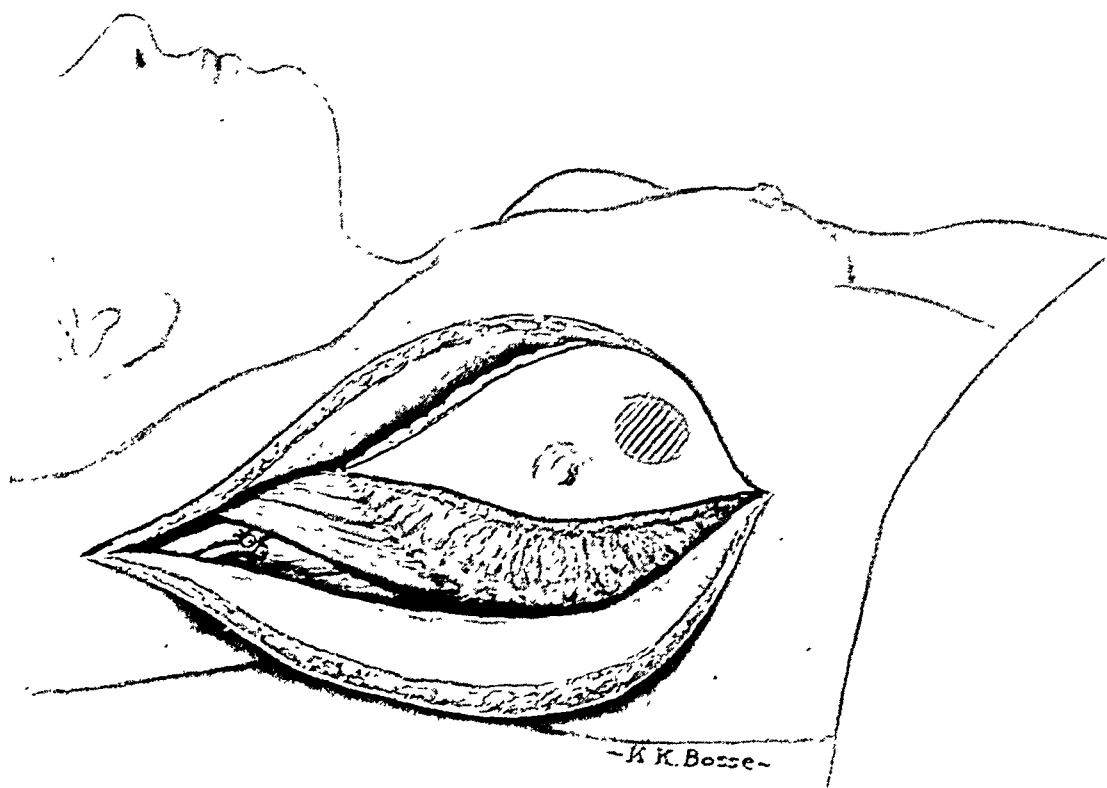


FIG. 2.—Radical breast amputation showing reflected amount of conserved skin dissected off the normal side of the breast, giving free access to axillary space and pectoralis major. Tumor in left lower quadrant.

breast farthest away from the tumor in the breast, depending upon its size and location. (Figs. 1 and 2.) Dividing the breast into quadrants, since tumors can be so classified, the skin is to be conserved by dissecting it off the side of the breast not containing the mass, thereby the amount of integument gained will be from two to three inches in width, extending the entire half diameter of the breast, and the closure of the wound, therefore, will be much more easily obtained with the least degree of tension. In many instances, the outline of the skin incision can be carried up to the areola of the nipple. It

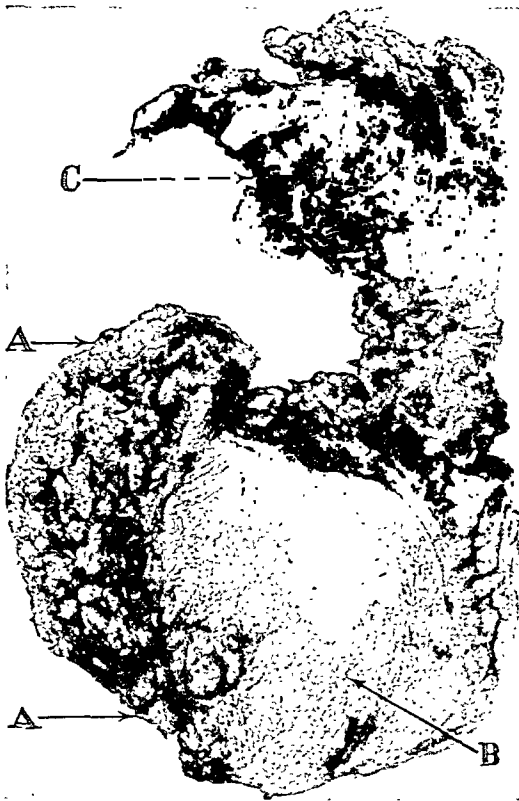


FIG. 3.—Mrs. A. K., aged forty. Carcinoma left breast. A-A—Normal side of breast. Conserved skin dissected off breast about $2\frac{1}{2}$ inches up to areola margin. B—Site of tumor. C—Axillary contents.

should never include the nipple or its areola, particularly when there is nipple retraction.

This partial subdermal amputation of the breast is bound to give the patient greater comfort, because the conserved integument covering the chestwall will be free, pliable, and non-adherent. Much greater flexibility of motion of the arm will be present very early after wound healing, will result in an artistic-looking suture line, while the operation is not more difficult of performance, and is less time-consuming because the closure of the wound is easier. Bunts, in "Lewis' Practice of Surgery," is the only one who mentions that the surface area of the skin should be smaller than the surface of the breast area to be removed.

By gaining two and one-half to three inches of skin area by this method of partial skin conservation (Fig. 3), it will not be necessary to

dissect the skin and undermine it beyond the circumference of the breast area, as it often must be done when the present classical incisions in vogue now are used.

According to Handley, some of the lymphatics lie directly below the skin, especially about the nipple, from whence they penetrate into the structure of the gland. This distribution radiates away from the integument towards the axilla, and towards the sternum through the pectoral muscles. But there is no direct lymph drainage or connection with the skin covering the breast.

Metastatic axillary lymph-node involvement is common in carcinoma of the breast, yet the skin covering the axilla is never removed, but the axillary contents, fat and lymph-nodes are dissected off of the skin covering the axilla.

All the recognized breast incisions do not sacrifice the skin covering the

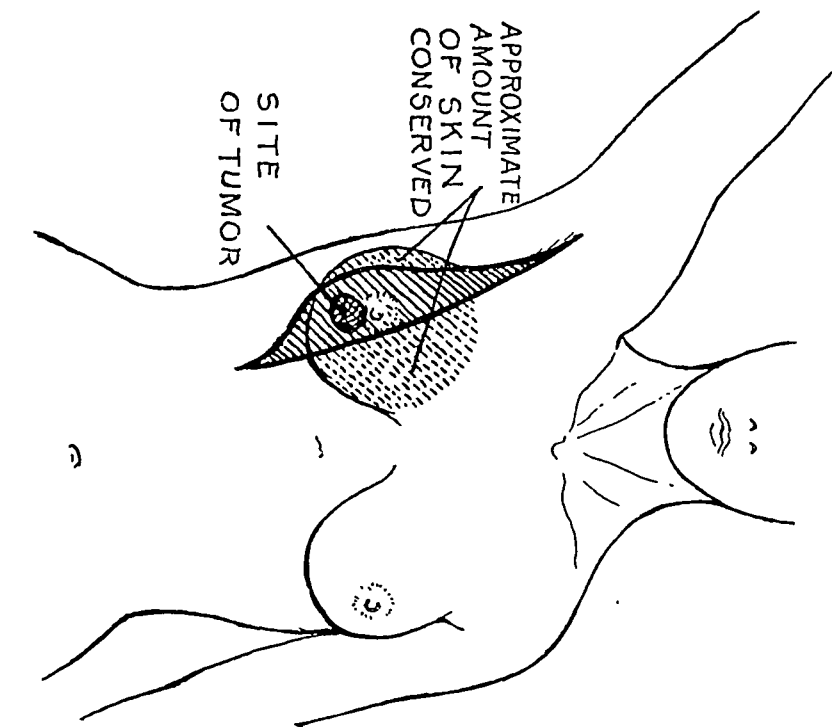


Fig. 4.—Tumor right lower quadrant. Dotted shading shows amount of skin conserved.

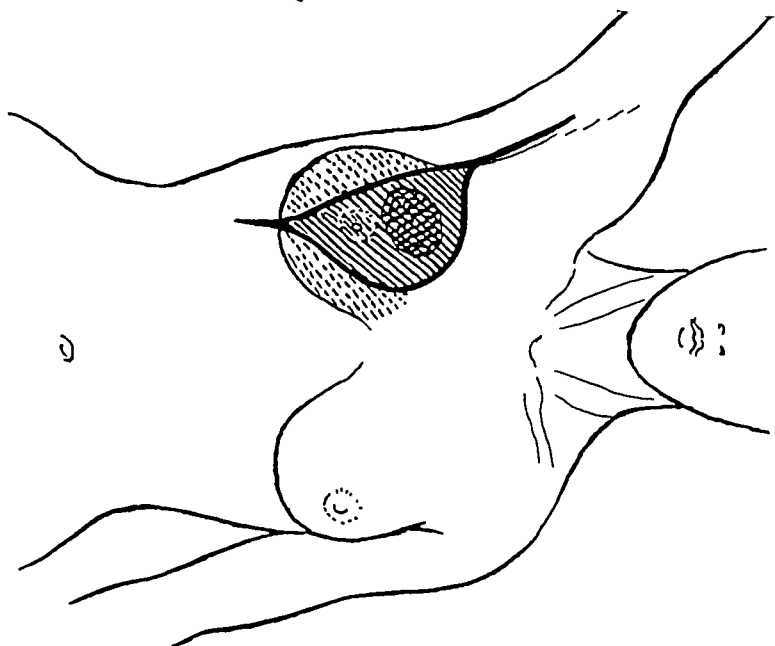


Fig. 5.—Tumor in middle upper quadrant. Dotted shading amount of skin conserved.

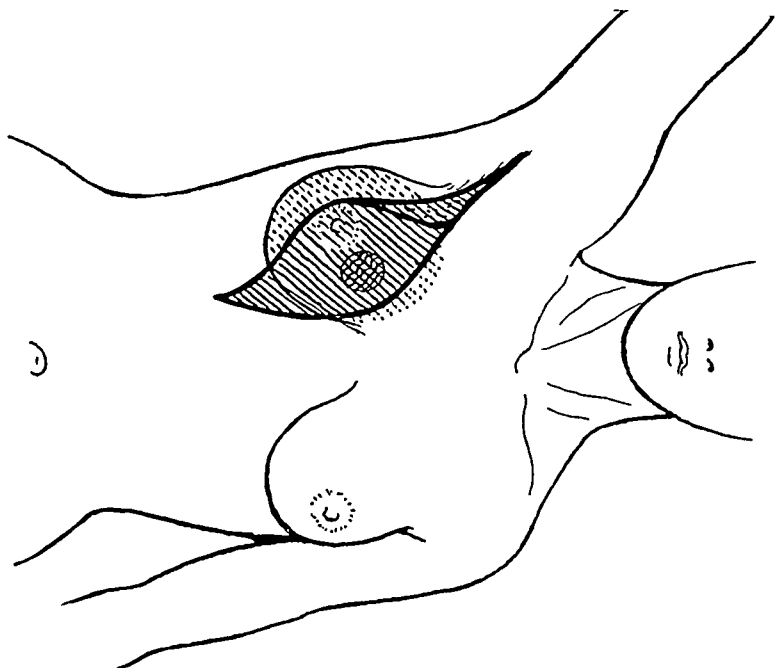


Fig. 6.—Tumor left middle and upper quadrant. Dotted shading amount of skin conserved.

axilla, though the axillary lymph-nodes are the seat of metastatic involvement. If it is important and necessary to remove the integument covering the breast far away from the tumor, the seat of carcinoma, how much more important would it be to remove the skin covering the axilla underlying which there are affected lymph-nodes. But this is never done. If it is safe, therefore, and it is, as experience teaches, to dissect and conserve the integument covering the axilla where axillary lymph-node involvement is present, is it not reasonable to feel the safety of dissecting and utilizing the integument of the breast opposite and distant from the tumor mass, so saving this extra amount of skin for easier closure?

While all the classical skin incisions for radical breast amputation have a well-defined outline, many provided with extensive side incisions for sliding flaps, in this suggested partial subdermal amputation, the outline of the skin incision is not constant but will depend upon the extent and location of the tumor, the amount of involved and adherent skin, as well as the good judgment and artistic sense of the surgeon. It must necessarily vary depending upon the above, as to how much skin can be conserved and dissected off the normal side of the breast. The underlying principle, however, remains the same, that is, that the skin covering the breast opposite to the tumor in the breast should be saved and dissected from the edge of the areola of the nipple, on to the outer circumference of the breast. In smaller tumors the skin of more than half the breast can be saved and be made available for easy suture.

Extensive conservation of skin in radical mastectomy has not to my knowledge been attempted nor its principles applied, probably because of the cancer fetish ever in mind. The entire breast, though the tumor may be a very small one, and the pectoral muscles are sacrificed, the pectorals, in many instances unnecessarily. I rarely remove them; certainly so far as the skin is concerned, the sacrifice is needless on the normal side of the diseased breast.

In plastic reconstruction of the pendulous breast the skin covering the entire mammary gland is dissected off, then after the breast is fixed in its new position, the skin is replaced without any injury to its viability, resulting in perfect healing. Having observed this surgical procedure there germinated the adaptability of skin conservation in breast amputation.

The method here suggested is a perfectly safe one, and while it has a very wide and varied applicability, it should not be attempted in cases which are far advanced nor where the skin covering the breast has been invaded or perforated. Even in cases with comparatively large tumor mass present, particularly in the scirrhus type of carcinoma, depending upon the good judgment of the surgeon, a considerable area of the skin can, nevertheless, with safety be dissected off the normal side of the breast opposite to whichever quadrant the tumor may be. Hæmostasis of the dissected flap must be thorough and kept covered with warm saline cloth while the major part of the amputation is completed. Retention sutures are usually not required. The outlines of the various incisions advocated are shown in Figs. 4, 5, and 6, which show also the amount of skin conserved compared with the total sacrifice.

OBSERVATIONS ON RUPTURE OF THE SUPRASPINATUS TENDON

BASED UPON A STUDY OF SEVENTY-THREE CADAVERS *

BY E. LAWRENCE KEYES, M.D.

OF ST. LOUIS, MO.

FROM THE DEPARTMENT OF ANATOMY, WASHINGTON UNIVERSITY SCHOOL OF MEDICINE

RUPTURE of the tendon of the supraspinatus muscle is a common cause of shoulder disability.¹ Traumatic rupture of this tendon occurs fairly often and may be cured by suture at operation²; it is related to subdeltoid or subacromial bursitis but it may escape detection due to lack of appreciation of its prevalence. Many cases of rupture of this tendon may be found in individuals over fifty years of age, although whether all cases cause symptoms cannot at present be stated. A condition so widespread is worthy of more attention than it has received up to now, so that the present investigation seems warranted.

Anatomy.—The tendon of the supraspinatus muscle, usually about six centimetres long, arises from the muscle belly in the supraspinous fossa of the scapula and runs across the capsule of the shoulder-joint to insert into the highest of three facets on the greater tubercle of the humerus. During the terminal half of its course it is inseparable from the joint capsule. Its two borders may be distinguished from the adjoining borders of the tendons of the infraspinatus and subscapularis only with some difficulty. It forms the roof of the shoulder-joint and the floor of the subacromial bursa,† lying beneath the deltoid muscle and the acromial process of the scapula. Together with the tendons of the infraspinatus, the teres minor, and the subscapularis, it adheres to and greatly strengthens the capsule of the shoulder-joint.

Normally, there exists no communication between the subacromial bursa and the shoulder-joint.

Definition.—Throughout this paper the term “rupture of the tendon of the supraspinatus muscle” has been limited to those perforations of the tendon large enough to establish a direct and grossly visible communication between the subacromial bursa and the shoulder-joint. Mere erosions of the tendon near its insertion on the greater tubercle have been excluded. Gross changes of adjacent structures have been recorded.

Method and Material.—An unselected series of seventy-three successive dissecting-room cadavers was examined. Most of the shoulders were studied at the time medical students were dissecting the short rotator muscles of the humerus; others were examined by a special dissection; and one shoulder showing a large rupture was dissected and preserved as a museum speci-

* This investigation was aided by a grant from the Science Research Fund of the Rockefeller Foundation.

† According to Codman, the subacromial bursa is identical with the subdeltoid bursa.

men. (Fig. 1.) Miss Marie Olds and Mr. Irving Harris assisted in the examination of some of the shoulder-joints, while Miss Mary Schmeckebier illustrated the museum specimen appearing in Fig. 1; and for their assistance due acknowledgment is hereby made.

All cadavers had been handled with sufficient care during transportation, injection, and preparation for dissection to obviate the possibility of a post-

TABLE I

Table to Show the Incidence of Ruptured Supraspinatus Tendons Among Seventy-three Cadavers According to Race, Sex, Age and Side

| AGE | | | White Males | Negro Males | White Females | Negro Females | Totals |
|-------------------|-----------------|----------|----------------|----------------|------------------|------------------|--------|
| NORMAL CASES | with Both | Below 50 | 8 | 15 | 1 | 4 | 23 |
| | Tendons Intact. | Above 50 | 12 | 12 | 3 | 4 | 31 |
| ABNORMAL CASES | with Both | Below 50 | 0 | 0 | 0 | 0 | 0 |
| | Tendons Torn. | Above 50 | 1 | 3 | 0 | 1 | 5 |
| | with Right | Below 50 | 0 | 0 | 0 | 0 | 0 |
| | Tendon Alone | Above 50 | 2* | 1 | 1 | 0 | 4* |
| | Torn | | | | | | |
| | with Left | Below 50 | 0 | 0 | 0 | 0 | 0 |
| | Tendon Alone | Above 50 | 1 | 3 | 0 | 1 | 5 |
| | Torn | | | | | | |
| TOTALS | | | 24 | 34 | 5 | 10 | 73 |

* In one of these cadavers the right shoulder alone was examined.

mortem rupture. Moreover, all the ruptures observed showed certain signs which indicated that they had originated during life.

The cadavers had been embalmed by injection into the femoral arteries of a solution of glycerine, alcohol and carbolic acid. The arteries had also been injected with starch colored by vermilion by way of the femorals or internal carotids. The shoulder-joints were all well preserved at the time of observation. The average period elapsing between the date of death and the date of dissection was twelve months, the shortest being three months and the longest twenty-four months.

Incidence.—Incidence based on lesions per cadaver differs from incidence

RUPTURE OF THE SUPRASPINATUS TENDON

based on lesions per shoulder. Thus, if three cadavers were examined, and one found to possess tears of both tendons, one to possess a torn right tendon and a normal left tendon, and one to possess two untorn tendons, the incidence of the lesion among cadavers would be two out of three or 66.7 per cent., while the incidence among shoulders would be three out of six or 50 per cent.

Rupture of one or both supraspinatus tendons was found in fourteen out of the seventy-three cadavers, an incidence of 19.18 per cent.; it was found in nineteen out of 142 shoulders examined, an incidence for shoulders of

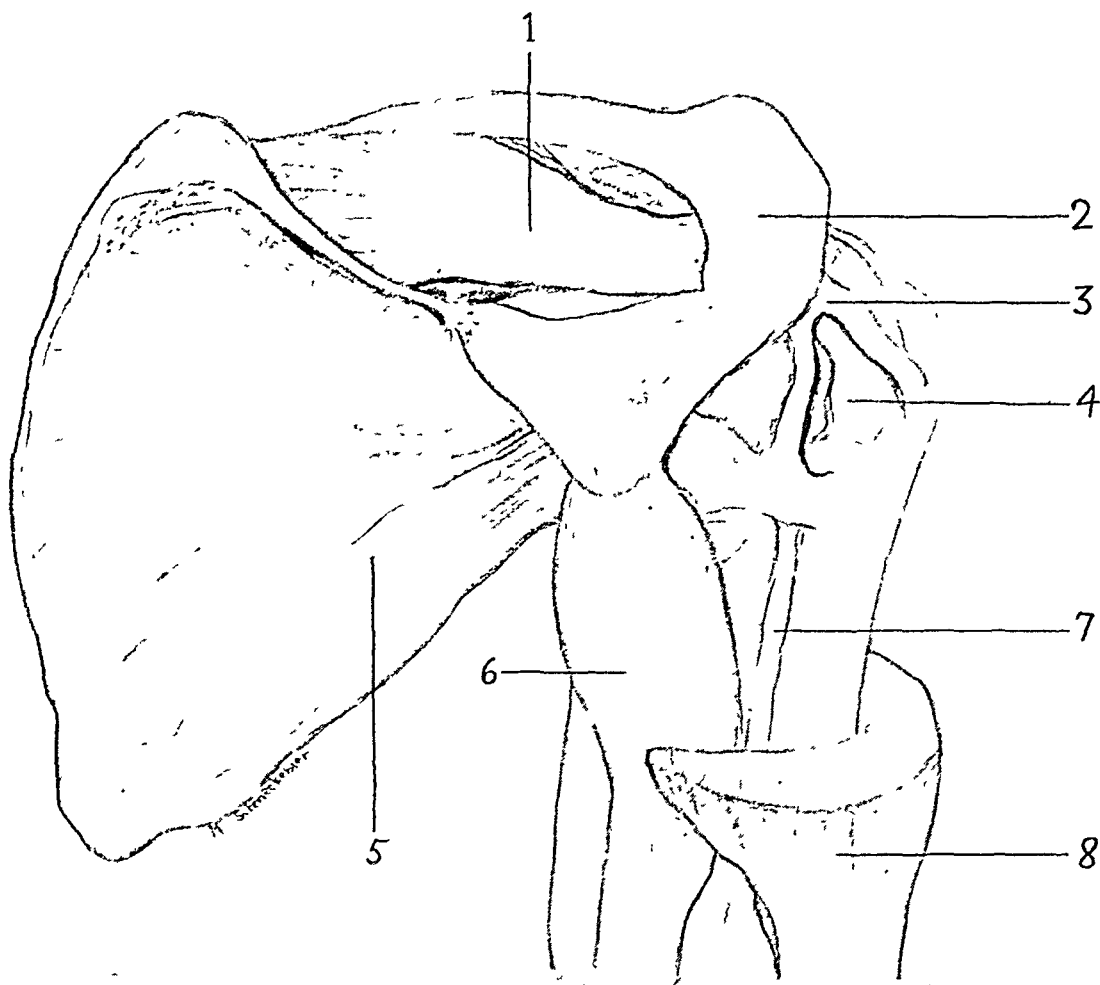


FIG. 1.—Dissection to show a large rupture of the supraspinatus tendon in the left shoulder of a Negro male aged eighty-six years whose right shoulder was the site of a similar smaller lesion. The clavicle and part of the deltoid muscle have been removed; the subacromial (subdeltoid) bursa has been dissected away to show the joint capsule with its inserting tendons. (1) Supraspinatus muscle; (2) acromion; (3) tendon of supraspinatus muscle; (4) tear in supraspinatus tendon; (5) subscapularis muscle; (6) coracobrachialis and short head of biceps muscles; (7) tendon, long head of biceps muscle; (8) deltoid muscle.

13.38 per cent. In four of the cadavers examination was limited to one shoulder.

Race.—The lesion occurred in five of the twenty-nine white cadavers, an incidence of 17.24 per cent.; it occurred in nine out of forty-four Negro cadavers, an incidence of 20.45 per cent.

Sex.—Eleven males out of fifty-eight had a torn tendon, an incidence of 18.97 per cent.; three females out of fifteen had a torn tendon, an incidence of 20 per cent.

Age.—The average age at death of all cadavers was 54.3 years; the average age at death of the cadavers possessing a ruptured tendon was 65.5 years. The youngest cadaver of the entire group was sixteen; the youngest cadaver with a torn tendon was fifty-one; no torn tendon occurred among the twenty-eight cadavers of the first five decades of life. All the fourteen cases of torn tendon occurred among the forty-five cadavers over fifty years of age, an incidence for this age group of 31.11 per cent. By decades the incidence was highest in the ninth, with two out of the four cadavers affected, an incidence of 50 per cent.; most cases occurred during the sixth decade with six affected out of the fourteen cadavers of that decade. The oldest cadaver with a torn tendon was eighty-six years of age, while the oldest cadaver of the group was eighty-eight years of age.

Shoulder Involved.—Both tendons were torn in five cadavers; one tendon only was torn in nine cadavers.* Of the unilateral tears, four* occurred in the right shoulder, and five in the left shoulder.

Relation of Age to Shoulder Involvement.—The average age at death of the cadavers with bilaterally torn tendons was 71.2 years; the average age at death of the cadavers* with unilaterally torn tendons was 62.3 years. The average age of cadavers with a unilaterally right-sided tear was 65.25 years, and of those* with a unilaterally left-sided tear was sixty years.

Description of the Lesion.—A typical lesion is illustrated in Fig. 1, and a description of it will include most of the features of other cases. The supraspinatus tendon may here be seen to split 0.7 centimetres lateral† to the acromion, and to proceed on either side of the tear to its insertion on the greater tubercle of the humerus. The tear or rupture in the tendon also pierces the underlying joint capsule, so that the joint cavity with some of the head of the humerus becomes revealed through it; in the undissected state the joint cavity would have opened through the rupture into the sub-acromial bursa. The shape of the rupture is triangular with the base along the greater tubercle, and perpendicular height parallel to the main axis of the tendon. The base measurement is 2.0 centimetres, the height 1.3 centimetres. A small bundle of fibres from the supraspinatus tendon remains traversing the rupture.

The torn tendon edges were seen in the original specimen to be smooth; but there was a little fraying of nearby portions of the tendon and of the long head of the biceps muscle. The greater tubercle was knobby and rough in its exposed portions, but normal elsewhere. Apart from the actual lesion the joint capsule as far as could be seen was smooth, and the inserting tendons of the short rotators were intact.

This description of one lesion covers the main features of all the other lesions of this series. The shape of all the ruptures was triangular, and all were confined strictly within the limits of the supraspinatus tendon. No tear of the supraspinatus tendon was complete or involved other tendons or

* In one of these, examination was limited to the right shoulder.

† The shoulder being in a normal resting position.

RUPTURE OF THE SUPRASPINATUS TENDON

other parts of the joint capsule. One tear was so large that its apex disappeared beneath the acromion, the shoulder being held in a normal resting position; but all others lay lateral to it and were strictly "subdeltoid" in location. In general, the older the cadaver the larger were the tears.

Fig. 2 illustrates average-sized ruptures of the two supraspinatus tendons of one cadaver; the drawing is to scale and represents the position and extent of the lesions and the amount of supraspinatus tendon protruding lateral to the acromion. The lesion on the right side was considered of "medium" size, the one on the left "small."

The knobbing of the exposed parts of the greater tubercle of the humerus was subject to some variation in degree and extent. No calcium deposits were found in either the subacromial bursa or in the tendon edges. Erosions of structures forming the floor of the subacromial bursa, that is to say, erosions involving the superficial fibres of the supraspinatus tendon or involving the periosteum or deeper bony substance of the greater tubercle unless associated with a tendon truly torn were not classified in this study, although encountered not infrequently. One of these erosions, however, was so remarkable as to require special description. It occurred in the left supra-

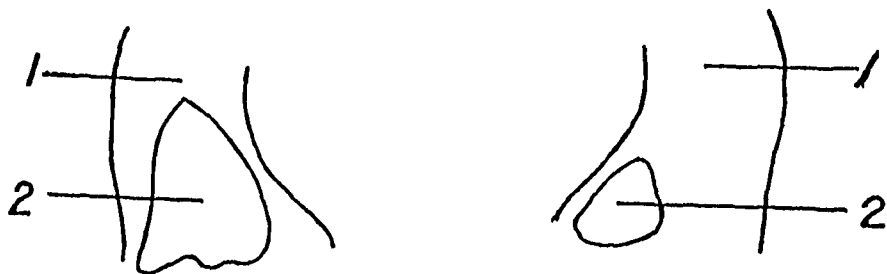


FIG. 2. —Tracings to show relative size, shape, and position of ruptures of the right and left supraspinatus tendons of a Negro female of seventy years. (1) Distal part of supraspinatus tendon; (2) tear in the tendon.

spinatus tendon of a white female, seventy-eight years old. It was remarkable for its similarity in size, shape and location to a rupture occurring in the supraspinatus tendon of the opposite side; and it differed from it only by reason of the fact that it did not completely pierce its tendon but involved merely its more superficial fibres.

No microscopical studies were made of any of the material.

Relation to Disease.—The causes of death of cadavers with torn tendons differed little from the causes of death of the other cadavers. It was impossible to determine the influence on the lesion of acute trauma, as adequate case histories were not available.

DISCUSSION.—Incidence per Cadaver.—The incidence per cadaver for various series was, in round numbers 48 per cent. for Akerson,¹ 5 per cent. for Codman,¹ and 19 per cent. for this series.

Incidence per Shoulder.—This incidence was found to be in round numbers 39 per cent. by Akerson,¹ 5 per cent. by Codman,¹ and 13 per cent. by the author.

Reason for discrepancy of these figures: Akerson's series comprised necropsy material obtained from aged individuals with chronic diseases. As

will be shown later, the incidence increased with age; so that Akerson's group, being older, would therefore show a higher incidence than the present series. Codman's series comprised dissecting-room material, necropsy material, and operative cases. Unfortunately, he failed to keep accurate records so that his figures represent merely an estimate of his observations, as he himself admits.

Incidence among Whites and Negroes.—The incidence here for white cadavers was about 17 per cent.; the incidence for Negro cadavers was about 21 per cent. Race, therefore, would seem without influence upon incidence of the lesion.

Incidence and Sex.—Akerson mentions that some of his subjects were females, but fails to mention the distribution of the lesion among the sexes. The incidence here for females was 20 per cent., and for males was about 19 per cent. Sex, therefore, would seem without influence on the incidence of the lesion; but in drawing this tentative conclusion it should be noted that the number of females in the series was much less than that of males.

Incidence and Age.—All observers have noted that the lesion was more common in old individuals than in young; but concise figures have hitherto been lacking. This series yielded some facts of interest in this connection. All the cadavers below the fiftieth year had normal tendons. On the other hand, fourteen of the forty-five cadavers above the fiftieth year possessed a torn tendon, so that almost one out of every three cadavers of an older age was affected. The ninth decade showed a higher incidence of the lesion than any other, two of the four cadavers being affected.

The average age for cadavers with torn tendons was 65.5 years, or 11.3 years above the average age for the group. The youngest cadaver to show a ruptured tendon was fifty-one years of age.

Young individuals appear rarely to possess ruptured tendons. The youngest case of torn supraspinatus tendon recorded in the literature was a man of thirty-five who sustained a traumatic rupture of the tendon and who was operated upon and cured by Wilson.²

Shoulder Involved.—Akerson found fourteen cases of bilaterally torn tendons and eleven cases of unilaterally torn tendons. This series showed five cases of bilaterally torn tendons and nine cases of unilaterally torn tendons. In Akerson's series the bilaterals were found more often, in this the unilaterals.

Of Akerson's unilateral cases, nine appeared to be unilateral rights and two unilateral lefts. Of the unilateral cases of this series, four were unilateral rights and five unilateral lefts. Adding up the two series, the unilateral rights would outnumber the unilateral lefts.

Relation of Age to Shoulder Involvement.—Bilateral tears occurred in older cadavers, unilateral tears in relatively younger cadavers. Apparently the same causative agent is sometimes at work in both shoulders and perforates first one and eventually both supraspinatus tendons. In this connec-

RUPTURE OF THE SUPRASPINATUS TENDON

tion it is interesting to note that the left unilateral tendon tears occurred in younger cadavers than the right unilateral tears.

Types of Tendon Tear.—All the ruptures of this series were strikingly similar one to another. All were triangular with the base along the greater tubercle. All were associated with a certain amount of tendon fraying and bony irregularity. The larger ruptures occurred usually in older cadavers, the smaller in younger.

Codman¹ says that occasional ruptures fail to perforate the floor of the subacromial bursa, but no such case was here observed.

Complete rupture of the supraspinatus tendon was not observed in this series. Wilson² has written an excellent article dealing with the clinical aspects and operative cure of complete rupture of the tendon; all his patients had completely ruptured supraspinatus tendons following trauma. The absence of this type of lesion in the present series might therefore be thought to indicate some other origin than trauma for the lesions encountered; although trauma probably causes a partial rupture at times.

Tears of adjoining tendons.—Akerson found that tears of one or all of the tendons of the subscapularis, infraspinatus and teres minor muscles often accompanied rupture of the supraspinatus tendon. No such accompanying tears occurred here. Meyer³ reports occasional destruction of the long head of the biceps muscle and attributes it to constant wear associated with long-continued use. All biceps' tendons were here intact.

Origin of the Lesion.—A common origin for all the lesions of this series is indicated by their similarity to one another and by their close association with age. If there were several different causes for the lesion, more variety would be expected in their characteristics and in their distribution among age groups. All the lesions were found in cadavers over fifty and were usually larger sized in older cadavers than in younger. It would seem as if some process were at work in the tendon which progressed with years, gradually causing degeneration first of the floor of the subacromial bursa, then wearing through the tendon at its insertion into the greater tubercle, and finally causing a perforation or rupture of the tendon. What the process is, whether traumatic, infectious, degenerative or metabolic, is beyond the scope of this study to determine.

SUMMARY AND CONCLUSIONS

- (1) Rupture of the tendon of the supraspinatus muscle occurs frequently. Its incidence among an unselected series of seventy-three dissecting-room cadavers was found to be 19.18 per cent.
- (2) It occurred only in cadavers over the age of fifty years.
- (3) Nine cases were unilateral, six were bilateral.
- (4) The cadavers with unilaterally torn tendons were younger than those with bilaterally torn tendons.
- (5) Four of the unilateral cases were rights, five were lefts.

(6) The cadavers with unilaterally right-sided torn tendons were older than those with unilaterally left-sided lesions.

(7) Race and sex were apparently without influence upon the distribution of the lesion.

(8) All lesions were remarkably similar to each other. There were no associated ruptures of other tendons.

(9) Age seemed the main factor influencing the distribution and character of the lesion.

(10) The process causing rupture of the supraspinatus tendon seems often to originate in the floor of the subacromial bursa, then to erode the superficial fibres of the tendon near its attachment to the greater tubercle and finally to perforate the tendon and joint capsule, thus opening up a communication between the subacromial bursa and the shoulder-joint. This process may act simultaneously and progressively in both shoulders.

BIBLIOGRAPHY

- ¹ Codman, E. A., and Akerson, I. B.: The Pathology Associated with Rupture of the Supraspinatus Tendon. *ANNALS OF SURGERY*, vol. xciii, p. 348, 1931. Review of literature appended.
- ² Wilson, P. D.: Complete Rupture of the Supraspinatus Tendon. *Jour. Am. Med. Assn.*, vol. xcvi, p. 433, 1931.
- ³ Meyer, A. W.: Further Observations Upon Use—Destruction in Joints. *Jour. Bone and Joint Surg.*, vol. iv, p. 491, 1922, *etc.*

PRIMARY JEJUNAL ULCER

BY WALTER W. EBELING, M.D.

OF PHILADELPHIA, PA.

FROM THE UNIVERSITY OF PENNSYLVANIA HOSPITAL

PRIMARY or simple jejunal ulcer is a lesion which is found infrequently. Many surgeons have had to care for the jejunal ulcer developing subsequent to a gastrojejunostomy. Few have had the opportunity of seeing or treating a patient suffering from such ulceration in the absence of previous stomach or duodenal surgery. While ulceration of the small intestines (more frequently the ileum) may occur in the course of typhoid fever, bacillary dysentery, cholera, and amoebic dysentery, the occurrence of a single ulcer (occasionally multiple) in the jejunum in the absence of profound systemic manifestations such as are seen in the acute enteric diseases noted above, is sufficient to arouse both interest and curiosity.

Incidence.—Judd,³⁰ in 1921, reviewing 4,324 gastrojejunostomies in which fifty-five gastrojejunal and jejunal ulcers had occurred, stated that not a single primary jejunal ulcer had been observed at The Mayo Clinic up to that time. Jancke,²⁷ in 1929, reporting several perforating ulcers of the small intestine, one of them jejunal, noted that only nine primary ulcers of the jejunum had been observed at The Mayo Clinic up to 1921. These two conflicting statements, the former from a surgeon of The Mayo Clinic and appearing in the American literature, the latter appearing in the German literature, deserve further elucidation.

Donati³⁷ (from Leotta), reviewing 8,060 autopsies, found gastric ulcers in 2.6 per cent., but not a single simple ulcer of the jejunum.

In this clinic from 1921 to 1932, 370 ulcers of the duodenum and jejunum were admitted to the surgical wards. Of this group, 319 came to surgery, and only two were primary jejunal ulcers. This frequency is somewhat above that commonly reported.

As Morrin,⁴⁴ Brown,⁸ Schilling,⁶¹ and Leotta³⁷ point out, a simple ulceration may occur in the ileum and Meckel's diverticulum. It seems illogical to include these ulcers in a clinical discussion of jejunal ulceration, although their pathology may be quite similar. In the majority of the reported cases, the jejunal ulcers appeared in the first loop and upper part of the jejunum. It is probable that ulcers in the ileum, Meckel's diverticulum, and even the lower jejunum, lacking the close proximity to the acid gastric and alkaline duodenal juices, have a different etiology from ulcers occurring in the stomach, pylorus, or duodenum. The relationship between these two types of ulcer is so remote that the latter may be excluded from a study of jejunal ulcers. While the symptoms of ileal and jejunal ulceration may closely simulate one another in the presence of perforation or obstruction, their dissimilarity becomes apparent when one studies jejunal ulcers that did not terminate in a perforative catastrophe.

From 1827 to 1932, only forty-seven (including author's case) primary

jejunal ulcers have been reported. Five of the reports are valueless for clinical study and have been added to the end of the table merely for completeness. The case of Moore,⁴³ so obviously traumatic with perforation into the urinary bladder, and the case of Pauchet⁴⁷ with multiple ulceration of the jejunum

TABLE 1.
PERFORATED JEJUNAL ULCERS.
(No Trauma)

| Author. | Year. | Age. | Sex. | Prev. Ulcer Hist. | Operated. | Result. | Post Mort. | Location of Ulcer. | Other Ulcers. |
|----------------------|-------|------|------|-------------------|-----------|---------|------------|--------------------|----------------------------|
| (60) Rufz | 1843 | 36 | M. | Yes. | No. | Died. | Yes. | Upper jejunum. | 3 in ileum. |
| (33) Krauss | 1844 | 55 | M. | - | No. | Died. | Yes. | Jejunum. | None. |
| (14) deCastlenau | 1843 | 52 | M. | - | No. | Died. | Yes. | Mid. jejunum. | None. |
| (50) Perroud | 1867 | 32 | M. | Yes. | No. | Died. | Yes. | Upper loop. | None. |
| (49) Parenski | 1876 | 45 | M. | - | No. | Died. | Yes. | Lower jejunum. | 4 in jejunum. |
| (55) Kronlein | 1886 | 61 | M. | None. | Yes. | Died. | Yes. | Jejunum. | 2 in jejunum. |
| (7) Brigidi | 1893 | - | M. | - | No. | Died. | Yes. | Upper jejunum. | 1 in jejunum & 1 in ileum. |
| (32) Kirmisson | 1898 | 8 | M. | None. | Yes. | Lived. | No. | Jejunum. | None. |
| (28) Jankowski | 1908 | 48 | M. | None. | No. | Died. | Yes. | Lower jejunum. | 1 in jejunum. |
| (39) Lett | 1919 | 54 | F. | Yes. | Yes. | Lived. | No. | Upper jejunum. | None. |
| (10) Cade | 1913 | 25 | M. | Yes. | No. | Died. | Yes. | Upper jejunum. | None. |
| (9) Bryan | 1916 | 48 | M. | Yes. | Yes. | Died. | No. | Upper loop. | None. |
| (34) Kretschmar | 1920 | 39 | M. | Yes. | Yes. | Died. | No. | Jejunum. | None. |
| (18) Fischer | 1921 | 58 | M. | Yes. | Yes. | Lived. | No. | Upper loop. | Old duodenal etc. |
| (56) Richardson | 1922 | 47 | M. | Yes. | Yes. | Lived. | No. | Upper jejunum. | None. |
| (56) Richardson | 1922 | 48 | F. | Yes. | Yes. | Lived. | No. | Mid. jejunum. | None. |
| (26) Holtzweissig | 1922 | 58 | F. | None. | Yes. | Died. | Yes. | Upper loop. | 10 in jejunum. |
| (11) Chiasserini | 1922 | - | M. | - | Yes. | Died. | - | Upper loop. | |
| (72) Veltz | 1924 | 77 | F. | None. | Yes. | Lived. | No. | Upper jejunum. | None. |
| (8) Barber | 1926 | 33 | M. | Yes. | Yes. | Lived. | No. | Upper loop. | Old pyloric. |
| (61) Schilling | 1930 | 47 | F. | None. | No. | Died. | Yes. | Mid. jejunum. | None. |
| (4) Black | 1930 | 53 | M. | Yes. | Yes. | Lived. | No. | Upper jejunum. | None. |
| (44) Morris | 1931 | 65 | M. | Yes. | Yes. | Died. | - | Upper jejunum. | None. |
| (44) Morris | 1931 | 39 | F. | - | No. | Died. | Yes. | Upper jejunum. | None. |
| (44) Morris | 1931 | 47 | F. | Yes. | Yes. | Lived. | No. | Jejunum. | None. |
| (67) Smith | 1932 | 27 | M. | Yes. | Yes. | Lived. | No. | Upper jejunum. | None. |

which presented no clinical or pathological characteristics of the usual simple ulceration, are omitted entirely. Of the forty-two cases in which the available data were sufficient for interpretation, but seven (author's case included) were operated on in the absence of perforation. The remaining thirty-five cases

PRIMARY JEJUNAL ULCER

(Table I) had perforated and, in this group, nine (Table II) are questionable because of the possibility of associated trauma having been responsible for the perforation.

Primary Jejunal Ulcer without Perforation.—A survey of the literature disclosed but six cases in which surgery had been performed because of digestive complaints and in the absence of perforation.

CASE I.—Schmilinski,⁹² 1910, female, aged sixty-three. Pain in the stomach for years. X-ray showed obstructive incompetence of the stomach and duodenum. A diagnosis of duodenal ulcer was made, and at operation the duodenum and jejunum were found to be dilated, with a stenosing induration of the jejunum and adjacent mesentery four centimetres from the duodenojejunal fold. Resection. A chronic ulcer was found on the mesenteric border. No evidence of lues or tuberculosis. The patient survived.

CASE II.—Murphy,⁴⁵ 1916, male, aged sixty-two. Digestive trouble for fifteen years. Pain occurred from one to three hours after meals. X-ray showed obstruction to the outlet of the stomach. A diagnosis of duodenal ulcer was made, and at operation an extensive inflammatory induration was observed about the duodenum which indicated the site of an ulcer. A second ulcer was noted in the first part of the jejunum. Anterior gastrojejunostomy was performed. The patient survived.

CASE III.—Walton,⁷⁴ 1922, female, aged forty-five. Stomach trouble for nineteen years, with epigastric pain of a periodic nature occurring late after food and relieved by food. X-ray showed an extraneous stomach mass with no evidence of obstruction. The diagnosis was uncertain. At operation an indurated and inflamed area about three feet from the duodenojejunal fold was discerned. Resection. The ulcer was round and compared in every way to a chronic gastric ulcer. No evidence of tuberculosis or lues. The patient survived.

CASE IV.—Fischer,¹⁰ 1923, female, aged forty-two. Epigastric pain of a periodic and constricting nature for one year. Melæna. X-ray examinations were repeatedly inconclusive. Diagnosis was uncertain. At operation an indurated area was found at the duodenojejunal junction. The gut was irregular, thick and œdematous, with a scarlet serosa covered with fibrin. Duodenojejunostomy. Since there was no pathological specimen malignancy could not be ruled out. The patient survived.

CASE V.—Ravdin,⁶³ 1927, male, aged forty-two. Dull epigastric pain two hours after food, associated with belching and relieved by soda. Six months' duration. X-ray examinations were negative. Diagnosis was duodenal ulcer, and at operation no ulcer was found; however, an appendectomy was performed. The patient became worse, and three months after the first operation X-ray examination showed a high jejunal obstruction. At a second operation the jejunum was found to be dilated to about twelve inches from the duodenojejunal fold where there was an annular sclerosing mass with enlarged lymph-nodes in the adjacent mesentery. Resection. The ulcer was of the chronic type. The patient succumbed.

CASE VI.—Pickhardt,⁶² 1930, female, aged sixty. Intermittent, general abdominal cramps, with vomiting. Three weeks' duration. Barium enema showed a twist at the sigmoid. Diagnosis was partial intestinal obstruction and at operation a circular stricture was found at about five feet from the duodenojejunal fold. Resection. The ulcer was of the chronic type. No evidence of a vascular lesion. The patient survived.

Our own case brings the number of reported cases up to seven. It appears to be the only one reported in which actual diagnosis of jejunal ulceration was made prior to operation. The history follows.

CASE No. 22834.—O. P., colored male, aged thirty-six. Admitted to the surgical service of Dr. E. L. Eliason at the Hospital of the University of Pennsylvania October 6, 1931, and discharged October 26, 1931. *Chief Complaint.*—Stomach trouble. *History*

of Present Illness.—Patient was apparently well until 1925, when he began to suffer from indigestion. He described his first attack as having followed the eating of grapes during the afternoon and a supper which did not digest that evening. He had a sour taste in his mouth and vomited the following morning. Vomitus was liquid, light in color, and sour. There was no blood. Following this attack he suffered from a continuous pain in the mid-epigastrium, persisting over a period of from six to eight weeks. The pain was somewhat relieved by belching, but was apparently not severe because the patient was able to continue doing light work. There were intervals of complete freedom from symptoms which lasted for several months at a time.

In 1927, the patient suffered from melæna; black stools persisted for five days. He had some loss of appetite, but very little pain. He remained under a physician's care for three or four months at that time.

In September, 1930, the patient had a most severe attack of indigestion with vomiting of food and bile associated with epigastric pain. He was admitted to the Atlantic City Hospital where he remained for a period of ten days. A röntgenological study was not made. He was placed on a Sippy diet, to which he strictly adhered for four months. This diet was then modified and continued with little alteration to the present time.

The pain associated with the attacks of indigestion was described as being in the mid-line of the epigastrium. It was lancinating in type, as though a person took a razor and kept making short cuts. Pain of this type would also occur about one hour after meals with occasional relief after food or alkaline powders. Further points in the history of present illness are not essential.

Past Medical History.—Malaria at eight years of age while living in South Carolina. No history of typhoid fever or dysentery. Denied venereal disease. Denied penile sore. In 1922, the patient developed a suppurative left inguinal adenitis which was diagnosed as luetic. A single positive Wassermann was obtained. The adenitis promptly subsided after incision and drainage. He received intravenous and intramuscular therapy in 1922 and intravenous therapy in 1923. During the course of treatment, and since that time, up to one year ago, his Wassermann has been repeatedly negative. No other operations. Family history and social history irrelevant.

Physical Examination.—Patient was a slender, poorly nourished colored male, thirty-six years old, who appeared to be ill. Temperature, 99° F.; pulse, 80; and respirations, 22. Scalp, nose, ears, eyes, mouth, neck, lungs, cardiovascular, and extremities were grossly negative. The abdomen presented moderate tenderness to palpation in the left upper quadrant, and in the epigastrium.

Laboratory Studies.—All within normal limits. The blood Wassermann was negative. Fæces strongly positive test for occult blood on meat-free diet. Fractional gastric analysis after test meal. No free acid in any of the six specimens or fractions. The quantity withdrawn was only sufficient to determine a total acid of twenty-two in the sixth specimen. Both the fasting and residue specimens showed a trace of occult blood. Both showed white blood corpuscles and epithelia.

Röntgenological Studies.—Gastro-intestinal series. Œsophagus, negative. Stomach, negative. Duodenum, cap negative by screen examination, unfilled on the films. Stasis in the duodenum and jejunum with obstruction in the first part of the jejunum due to ulcer or adhesions. (Fig. 1.) Remainder of small intestine, negative.

Pre-operative Diagnosis.—Jejunal ulcer.

Operation.—Under spinal (neocaine) supplemented with gas-ether anæsthesia a mid-line incision was made from the ensiform to the umbilicus. Stomach, prepylorus, pylorus, and duodenum were first examined and found to be entirely normal. Gall-bladder normal. Examination of the jejunum revealed a stenosing lesion involving almost the entire circumference of the bowel and causing a partial obstruction six inches from the ligament of Treitz. The bowel proximal to the stenosis was distended and hypertrophied. Palpation revealed only moderate induration and the impression was that the condition was probably a jejunal ulcer.

PRIMARY JEJUNAL ULCER

Approximately four inches of the jejunum were resected, thus completely removing the ulcer-bearing portion of the bowel. After inversion of the cut ends of the proximal and distal jejunum, continuity was restored by lateral anastomosis.

Progress.—Patient reacted promptly and satisfactorily after operation. Wound healed by primary union and the patient was discharged from the hospital on the seventeenth post-operative day much improved.

Pathological Report.—Specimen consisted of part of the jejunum which measured about five centimetres in length. (Fig. 2.) In the middle there was an annular ulcerating lesion. The ulcer was shallow, and its base was covered with small blood-

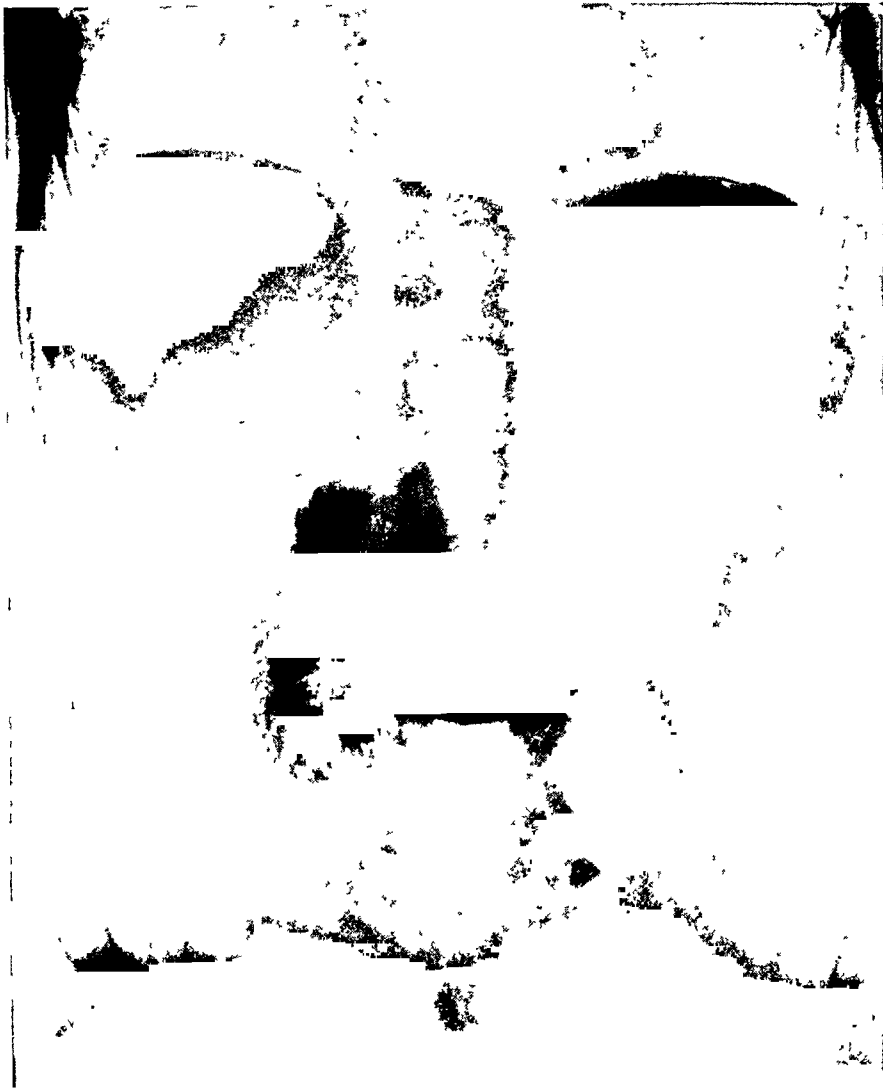


FIG. 1.—Röntgenogram showing dilated proximal jejunum and actual site of stenosis. (Spasm.)

clots. There was no gross evidence of infiltration. Sections showed the ulceration down to the muscularis mucosa. (Fig. 3.) There was small round-cell infiltration and fibrosis. No evidence of tuberculosis. Levaditi stain did not demonstrate any spirochaetes.

Follow-up Examination.—Approximately five months after operation. Slight post-prandial epigastric discomfort immediately relieved by alkali. Otherwise completely relieved of symptoms, and feeling much improved. X-ray showed slight widening of the lumen in several coils of small intestine in the left upper quadrant, with small amount of regurgitation, but no obstruction. Hypomotility.

Etiology and Pathogenesis.—An enteric fever (typhoid), bacillary or amœbic dysentery, or cholera, however remote, may serve as the initial factor

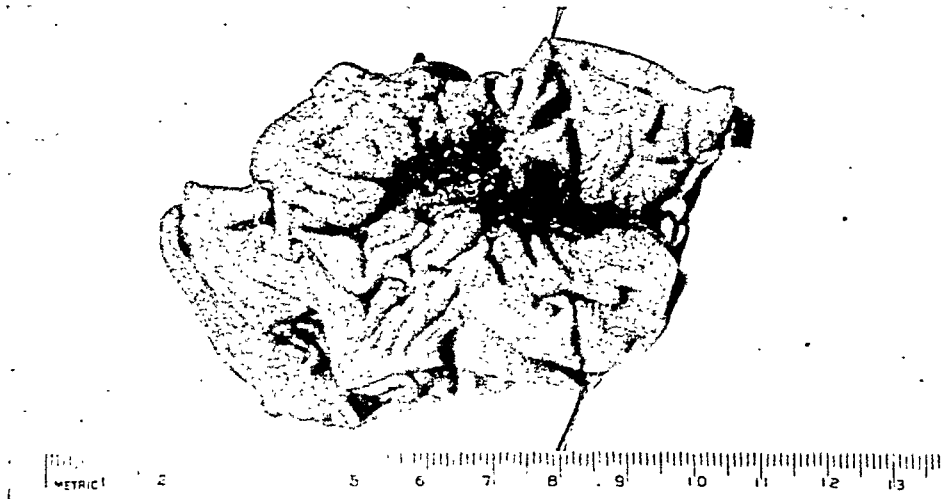


FIG. 2.—Gross specimen showing jejunal ulcer. Needles are situated at proximal and distal ends of specimen.

in the production of jejunal ulcer. Later, the ulcer may be maintained through the irritative action of the acid or alkaline intestinal chyme, thus attaining

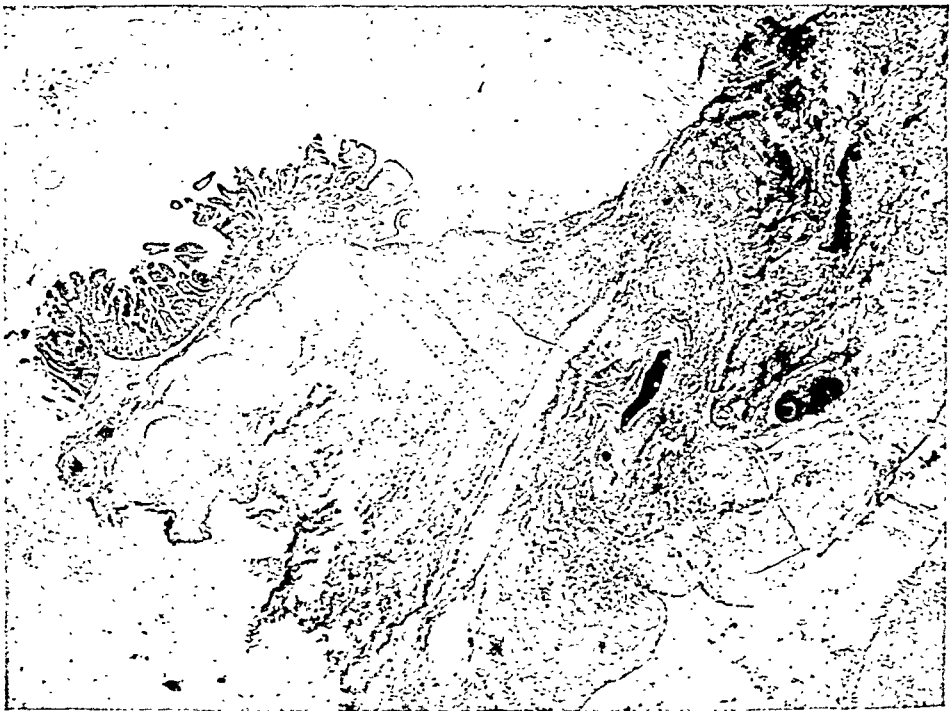


FIG. 3.—Low-power section through side of ulcer. Mucosal ulceration. Muscularis slightly broken. Fibrosis and round-cell infiltration. Levaditi stain negative for spirochæta pallida.

clinical significance. This concept would appear to agree with that of Bolton,⁵ who believed that most acute ulcers healed rapidly and that chronic ulcers

resulted only from unhealed lesions. He worked with gastric and duodenal ulcers.

There was a tendency in the earlier reports to use the term "peptic" ulcer instead of primary jejunal ulcer. This terminology is open to serious question. In three of the collected cases, (Schmilinski,⁶² Walton,⁷⁴ and Smith⁷⁷), as well as in our own, there was an absence of, or at least very low free hydrochloric acid in the gastric secretion as shown in the fractional gastric analysis of the test meal. The histamine test was not used. In the presence of these findings, one finds it difficult to accept the term "peptic ulcer," which implies the action of the acid gastric juices. Acid intestinal contents have been observed in the jejunum (Roeder⁷⁷). Mucous membrane similar in character to that of the gastric mucous membrane has been observed in the small intestine and in Meckel's diverticulum (Nicholson,⁴² Sweet,⁷⁰ Stone,⁶⁹ and Hartglass²⁵). Grassman²⁴ reported success in producing ulcers in the small bowel of dogs as a result of tryptic digestion. While it is highly improbable that the acid concentration of the jejunal contents might rise to singularly abnormal heights, one such case has been observed by Holtzweissig.²⁹ In this case, because of obstruction of the ampulla of Vater, the acid gastric juices were not neutralized.

Cornioley¹² believed that simple ulcers were always preceded by local circulatory difficulty manifested as an endarteritis of the arterioles in the submucosa of the bowel. In older patients vascular changes may exist, while in younger ones a metastatic bacterial embolus may produce the ulceration. This type of ulcer will have no tendency to become chronic, but is likely to perforate at any time from its inception. The majority of the ulcers in the collected case reports were of the chronic type. One cannot readily support the hypothesis that the embolic factor is of importance in the absence of any demonstrable source of the emboli or of any other embolic phenomena. In reviewing the literature, it was noted that several authors stated that no vascular changes were evident, although some case histories were not explicit as to whether or not any vascular changes had been noted in the microscopical sections.

Rosenow⁵⁸ believed and proved rather conclusively in animal experimentation that specific strains of streptococci produce intestinal ulceration. A few cases of small intestinal perforation incident to focal infection have been reported. Gale²³ cited a case of repeated intestinal perforation in a woman, aged forty, each perforation having been preceded by furunculosis of the external auditory meatus. Lemierre and Levesque³⁸ reported ulceration of the ileum due to pneumococcal infection and isolated the organism from the ulcer, the primary focus being in the lungs. Pesce⁵¹ similarly noted the association of tonsillitis with perforation of an ulcer.

Intestinal ulceration may occur in uræmia. Dickinson¹⁵ reported eleven cases of uræmic ulcers of the small intestines. These ulcers were regular in outline, circular, punched-out, and without thickened edges. He stated that perforation was common in this type of ulcer. These ulcers are probably not unlike those which occur after severe burns and, experimentally, after partial⁴¹ or total⁴⁰ destruction of the adrenals, or exclusion of pancreatic juice by ligation of the pancreatic duct.¹⁷

Friedman²¹ adheres to the view that excess or deficiency of endocrine secretion acts directly on the walls or on the vessels of the whole gastro-intestinal tract, and that small areas become devitalized through this interference with their blood supply. Ulceration would then ensue through bacterial invasion or because of the caustic action of the hydrochloric acid.

Ulceration commonly occurs at the site of carcinoma or new growth and, as in the case cited by Renon and Blatmoutier,⁵⁴ ulceration and perforation of the small intestine occurred secondary to obstruction due to carcinoma. Paterson Brown⁸ cautioned against the inclusion of such ulceration in a collection of so-called primary jejunal ulcers. Two carcinomata of the small intestine have been observed personally, both with subacute obstruction, and in neither instance was such proximal ulceration noted, although there

was slight local ulceration of the new growth. Papin⁴⁸ reported a carcinoma of the appendix with ulceration.

Trauma may be the initial cause of chronic ulceration and, in some cases, will be directly responsible for perforation. The case reported by Moore,⁴³ which I have excluded from the series of perforated ulcers, is an example of this type. Simmons and von Glahn⁴⁵ failed to produce ulcers after the administration of ground glass to dogs. In nine of the ulcers presented under the perforated group, the question of trauma as an etiological factor arises. It is entirely possible that the ulcer was already present in several of these cases, the trauma actually provoking the perforation. The cases reported by Dodson,¹⁶ Reverdin,⁴⁵ and Wagner⁷³ probably belong to this group for the ulcers noted at autopsy were of the chronic type. Four ulcers were known to be acute. In the case cited by Friele,²² the cause of ulceration was a blow to a truss worn by the patient. Sestier's⁴⁴ patient had a strangulated hernia, and ulceration occurred about the strangulation. Simpson's⁶⁶ case was a dement, and at autopsy the intestinal tract was found to be filled with wood fibres, although none was presenting through the site of ulceration, nor were any fibres reported in the peritoneal cavity. Jankowski's²⁹ case (1910) perforated after a meal of cherries and at autopsy large masses of cherry stones were found in the intestinal tract. It was assumed that a sharp edge on one of these stones was responsible for the perforation. However, in this same case, the patient had suffered a severe attack of abdominal pain twenty years previously. The exact significance of this attack is not apparent, although one might conclude that some previous ulcer had perforated. In two of the remaining nine cases, while the author concluded that perforation was due to trauma, the exact nature of the trauma was not mentioned.

Tuberculosis must be excluded as an etiological factor in the production of simple jejunal ulceration. In those cases in which no specimen is available, the presence of a pulmonary or laryngeal tuberculosis and, possibly, the identification of acid-fast bacilli in the stools would lead one to suspect the presence of a tuberculous ulcer. The presence of tubercles in the ulcer would enable one to make a positive diagnosis. Cruice,¹³ in 1911, in an extensive review of the literature to that date, quoted numerous writers and noted that intestinal ulceration occurred in from 29.9 per cent. to 90 per cent. of cases of pulmonary phthisis for separately reported series. He also noted that perforation of ulcers of acid-fast origin occurred in from 1 to 5 per cent., the former being the more nearly accepted figure. Richardson,⁵⁶ reporting 4,200 autopsies at the Massachusetts General Hospital, found forty-nine cases of tuberculous ulcers, in forty-three of which the ileum was involved, and in five of which the jejunum and ileum were both involved. Gross perforation was found but three times, and then in the ileum. Lazerevic³⁶ reported a stenosing tuberculous ulcer of the jejunum which led to perforation. The tuberculous nature was disclosed at microscopical examination. While some of the writers omitted to mention that there was no evidence of tuberculosis, none gave any data to support the view that the tubercle bacillus was responsible for the production of the ulcer.

The exclusion of syphilis as an etiological factor is most difficult. Syphilis may produce intestinal ulcerations. Fraenkel,²⁰ in a series of 19,000 autopsies, reported three cases of acquired syphilis of the small intestine, one an ulcer in the ileum, and two in the jejunum. Weiss⁷⁵ reported perforation seven times in thirty-five cases of syphilis of the intestines. Obendorfer⁴⁶ reported

twenty-four cases of acquired lues, five of which had an associated gastric syphilis. Eighteen of these cases had ulcers in the small intestines, nine of which appeared in the jejunum alone, or in the jejunum and ileum. Two of these perforated. Arkin,¹ in a thorough discussion of syphilitic intestinal ulceration, came to the following conclusions: (1) Acquired luetic ulcers frequently occur in the jejunum. (2) The spirochæta pallida are present in these ulcers. (3) The changes are usually submucosal: (a) gummatous ulceration, (b) endarteritis, (c) endophlebitis, (d) advanced miliary phlebitis, (e) endothelial-cell proliferation. (4) Acquired luetic ulcers are usually accompanied by changes in the liver, spleen; rarely in the brain, thyroid, adrenal, pancreas, and long bones, except the tibia. (6) Diagnosis of the lesion can be made by (a) demonstration of the spirochæte in the lesion, (b) vascular changes, (c) other luetic lesions, (d) absence of tubercles in lesions, glands, or liver, (e) absence of tubercles on the serosa, (f) frequent location in the jejunum.

Karsner³¹ states that luetic lesions of the intestinal tract occur late in the acquired form of syphilis as gummata. They particularly affect the rectum, sigmoid, and other parts of the colon, but are rarely observed in the small intestine. The gumma breaks down to form an ulcer of the chronic type, often extending transversely across the gut. There is usually a necrotic central mass surrounded by endothelial or lymphoid cells in association with well-marked chronic inflammation in both arteries and veins which may undergo actual occlusion. Cicatricial contraction of the intestine is common, due to fibrosis.

In the reported case this problem deserves unusual consideration. It is worthy of note that this patient suffered from inguinal buboes which suppurated three years prior to any gastric symptoms. His physician made a diagnosis of syphilis on a single Wassermann reaction. The patient then received a fair course of antiluetic therapy for two years. All subsequent Wassermann reactions were reported as negative, even during the course of therapy. The patient denied having had a primary penile lesion. The Wassermann reaction while under our care was negative. This was ten years after the initial diagnosis of syphilis.

According to Stokes,⁶⁸ inguinal buboes appear in only 30 to 40 per cent. of those cases presenting actual chancre, and suppurate in few instances. A single positive Wassermann reaction does not make conclusive a diagnosis of syphilis. It is highly probable that this patient did not have syphilis in the first place. If he did have syphilis, a fairly intensive course of antiluetic treatment was given, and all subsequent Wassermans were negative, even ten years after the possible inception. The gross microscopical and Levaditi pictures of the ulcer removed showed no evidence of syphilis. The patient presented no stigmata of the syphilitic.

In a few of the reported cases, the question of lues arose. Fraenkel²⁰ thought that Schmilinski's⁶² case might be syphilitic. The Wassermann reactions in four of the non-perforative ulcers were negative. The remaining three were not reported. Only two of the cases in the perforative series

had negative Wassermann reactions (Black⁴ and Morrin⁴⁴), while Richardson reports negative Levaditi stains on two specimens. The remainder of the series presented no Wassermann reports.

This problem is best summed up in the words of Richardson,⁵⁶ "The proof that a lesion of the small intestine is syphilitic is not easy. . . . There is no conclusive point by which the nature of the syphilitic lesion may be recognized in all its stages unless the *spirochæta pallida* is demonstrated in the lesion. Conversely, the exclusion of syphilis as the cause of intestinal ulceration is correspondingly difficult."

A review of the literature brings out the fact that the etiology of jejunal ulcer is as obscure at present as is that of the more common duodenal, pyloric, or gastric ulcer.

Pathology.—Thirty-four of the entire series (forty-two) were localized as to the portion of the jejunum they occupied. Of the non-perforated group, four were within the first or upper loop of the jejunum, two were in the upper jejunum, and one in the mid-jejunum. Of the perforated group, nine were in the first or upper loop, ten in the upper jejunum, four in the mid-jejunum, and four in the lower jejunum. The majority of the ulcers were obviously in the upper jejunum. One is led to conclude from the predilection of this ulceration for the proximal portion of the jejunum that these lesions are possibly entirely different from those ulcers which occur in the ileum where known specific ulcerations are the result of invasion of the aggregate lymph patches.

The majority of the ulcers were situated opposite to the mesenteric attachment. Of the two cases in the non-perforated group in which the relation to the mesentery was recorded, one was antimesenteric, and the other was near the mesentery. In the perforated group in which this point was recorded, sixteen were antimesenteric, and two were near the mesenteric attachment.

Apparently chronicity tended to stricture formation. In four of the non-perforated ulcers where stricture formation had been noted, all were of the chronic type. In the perforated group, seven of which showed stricture formation, six were recorded as having been chronic. The seventh history failed to state whether or not the ulcer was chronic. The formation of a stricture implies actual stenosis due to scar-tissue infiltration. However, in the reported case, the stenosis was due in large part to constricting spasm of the ulcer-bearing portion of the jejunum.

The descriptions of the ulcers were practically the same. They were often described as being exactly similar to the chronic peptic ulcers occurring in the stomach or duodenum. They were clean-cut and punched out. In cross-section they tended to show a terrace formation of the edges. The degree of induration was variable. The size varied from that of a pea to the size of a small coin (two centimetres). The perforated ulcers usually presented a minute opening described variously as the size of a knitting needle, lentil, or a coin, the former measurements predominating. In several instances the minuteness of the perforation was responsible for the surgeons' failure to

PRIMARY JEJUNAL ULCER

find the ulcer and its perforation. The mucous membrane participated to a greater extent in the necrotic process.

The configuration of the ulcers was predominately circular. While some of the records were not explicit in this particular, three histories of the non-perforated group state that the ulcers were circular and two that they were annular. Of the perforated group, thirty-one were recorded as being circular, and six annular.

Microscopically, the ulcers showed varying degrees of round-cell infiltration and fibrosis. Necrosis varied from the superficial mucous-membrane destruction to the involvement of the submucosa and deeper layers, and to actual perforation through the serosa. While several microscopical reports definitely stated that no vascular changes were apparent, none reported actual characteristic alterations other than thrombosis. Chronicity predominated. In those ulcers in which the observation was recorded, twenty-three were chronic, three were subacute, and six acute. Four of the acute ulcers in the group occurred or perforated after trauma.

Few of the writers recorded the presence or absence of enlarged regional lymph-glands (mesenteric). In those instances in which these glands were examined microscopically, the changes noted were those due to chronic inflammation. The presence or absence of glands would lead one to speculate on the possibility of malignancy.

Additional ulcers were observed in nine of the cases. Parenski's,⁴⁹ Kronlein's,³⁵ and Jankowski's²⁸ all showed two or more ulcers in the jejunum. Holtzweissig's²⁶ case showed eight ulcers in a ten-centimetre area of the jejunum. Rufz's⁶⁰ case had three ulcers in the ileum, and the case history was very suggestive of a previous enteric fever. Brigidi's⁷ case showed an ulcer in the ileum. Fischer's¹⁸ case showed an old healed duodenal ulcer and numerous chronic infiltrations in the bowel wall distal to the position of the reported ulcer. Barber's³ case showed an old healed pyloric ulcer, and this patient had been operated upon twice previously for perforated ulcers of the stomach. Murphy's⁴⁵ case had a duodenal ulcer. The presence of associated ulcers in the ileum leads one to suspect that one of the enteric fevers was a causative factor. The presence of additional ulcers in the jejunum is of interest, particularly in view of the fact that two or more ulcers in the duodenum are often seen at operations for peptic duodenal ulcer.

Symptomatology.—In those histories in which the patients' ages were recorded, the primary jejunal ulceration was found to have occurred between the ages of eight and seventy-seven. The majority of the cases appeared between the ages of thirty-one and sixty, predominantly from forty to sixty. Likewise, where sex was recorded, ulcers occurred in thirty males and eleven females, making a ratio of three males to one female. (Fig. 4.)

In the non-perforated series, gastric complaints were manifest for from three weeks to fifteen years. While the predominant complaint was pain in the stomach, epigastrium, or general abdomen, five patients presented

symptoms not unlike those noted in cases of peptic ulcer of the duodenum; the pain occurred from one to three hours after meals, occasionally late at night, and was relieved by food or alkalis. Pain was occasionally referred to the back, right upper quadrant, or lower abdomen. Periodicity was recorded in five cases, and it is interesting to note that the one ulcer three feet beyond the duodeno-jejunal flexure presented symptoms of this character. In those ulcers which caused stenosis, subacute obstructive symptoms were manifest, such as cramp-like pains, distension, vomiting, with some Cases.

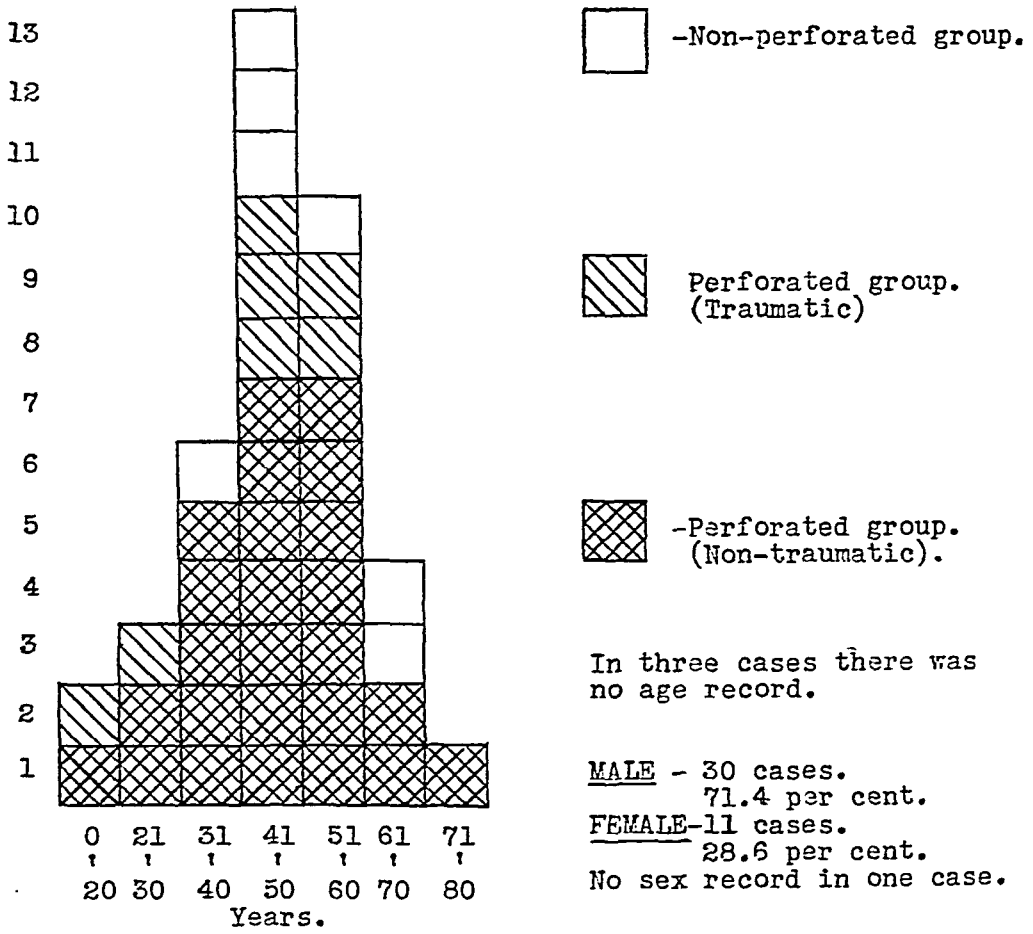


FIG. 4.—Primary jejunal ulcer-age and sex incidence. Forty-two collected cases.

relief by lavage. Melæna was recorded in two cases. Hematemesis was observed in Murphy's⁴⁵ case. However, the presence of an associated duodenal ulcer minimizes the value of this observation. Constipation was occasionally recorded.

In the perforated group, seven of the cases were entirely free of digestive complaints up to the actual time of perforation. Thirteen of the records failed to comment on this point. The remaining fifteen presented variable symptoms. Ten of the cases had symptoms of a dyspeptic nature for a period ranging from two months to six years. Indigestion was the com-

PRIMARY JEJUNAL ULCER

plaint in four instances. Pain of a colicky nature, heart-burn, stitch in the side, pain in the epigastrium or lower abdomen was recorded in ten. Melenæ was noted only in two. Symptoms of an obstructive nature, such as distension, constipation, belching, nausea and vomiting were observed in eight cases. In only three cases in which previous symptoms were recorded did the digestive complaints, or pain, simulate or suggest the presence of a peptic ulcer as outlined under the non-perforative group.

The perforative catastrophe was announced by a sudden, severe, and occasionally colicky pain in the abdomen. In two instances in which the perforation might have been called subacute, there was only an increased severity

TABLE II

| PERFORATED JEJUNAL ULCERS. (History of Trauma) | | | | | | | | | |
|---|-------|------|------|-------------------|-------------|---------|-------------|---------------------|--------------------------------------|
| Author. | Year. | Age. | Sex. | Prev. Ulcer Hist. | Perforated. | Result. | Port. Mort. | Location of Ulc. p. | Nature of Trauma. Other Ulcers. |
| (64) Sestier | 1827 | - | - | None | - | Died. | - | Jejunum. | Strangulated hernia with ulceration. |
| (73) Wagner | 1858 | 18 | M. | - | No. | Died. | Yes. | Upper loop. | Buried by earth. |
| (71) Taylor | 1865 | 45 | M. | - | No. | Died. | Yes. | Jejunum. | Fall; wrestling and drinking. |
| (55) Reverdin | 1867 | 55 | M. | - | No. | Died. | Yes. | Mid. jejunum. | Intoxicated and fell. |
| (66) Simpson | 1897 | 56 | M. | - | No. | Died. | Yes. | Upper loop. | Derent. Wood fibers in int. tract. |
| (16) Dodson | 1906 | 57 | M. | - | No. | Died. | Yes. | Lower jejunum. | Abdominal bruise. |
| (29) Jankowski. | 1910 | 42 | M. | - | Yes. | Died. | Yes. | Lower jejunum. | Cherry stone meal. |
| (12) Friele | 1894 | 46 | M. | Yes. | Yes. | Lived. | No. | Jejunum. | Struck truss. |
| (27) Jancke | 1929 | 28 | M. | - | - | Died. | | Upper loop. | Trauma (?) |

of the past complaint, pain. In only two of the twenty-six perforated ulcers not associated with trauma did the records omit these notes.

In those perforated ulcers associated with trauma, only five of the nine patients complained of pain in the abdomen. The remaining histories did not comment on this point. (Table II.)

The pain heralding the perforation was general in fifteen cases. The remainder presented some localization. Epigastric pain was mentioned in four, umbilical in three, lower abdominal in seven, pain in the lower right quadrant in one, lower left quadrant in four, and upper left quadrant in one. It is interesting to observe that in no case was the pain, either by early or late localization, referred to the right upper quadrant, and, in only

one instance, to the lower right quadrant. The pain reference was extremely variable and was recorded in only seven cases. Reference to the thighs, shoulders, back, loin, and flank were mentioned.

Obstructive symptoms—distension and constipation, were noted in nineteen cases, while vomiting was recorded in seventeen. The signs of peritonitis—a rigid, silent, and tender abdomen, were recorded in twenty-seven cases, the remaining eight having failed to comment on this point. The abdominal rigidity was usually board-like. Liver dullness was absent or diminished in seven cases in which observations on this point were made.

Diagnosis.—It has been exceedingly difficult to form a clear and concise clinical picture of this condition from the data collected. Much of the desired information has been omitted from the records or case reports, and the material available has often been entirely inadequate for analysis.

Indigestion and dyspepsia lasting from months to years with pain, usually epigastric, occurring from one to three hours after meals, tending to be periodic, and occasionally relieved by food or alkalis, should lead one to suspect a peptic ulcer. While the ulcer may be, and usually is duodenal, the jejunum must not be excluded. Stenosis of the bowel will add such obstructive symptoms as distension or flatulence, belching, vomiting, constipation, and colicky pains which are often relieved by gastric lavage. Only two cases (Schmilinski⁶² and Murphy⁴⁵) had hematemesis, although one (Murphy) might have been attributed to an associated duodenal ulcer. As Ravdin⁵³ has observed, the nearer the ulcer to the duodenum, the closer the pain relation to food and alkali, although the actual time intervals are as variable as those one sometimes sees in cases of duodenal ulcer. Melæna may occur in this ulceration as in any other.

Acute, sudden, and severe abdominal pain coupled with the fulminating symptoms of peritonitis (distension, vomiting, and obstipation) as well as the signs of peritonitis (silent, tender, board-rigid abdomen) should lead one to a diagnosis of a perforated ulcer. While there may be no previous ulcer history, the symptoms and signs are characteristic. The perforation will be more commonly in the duodenum or stomach, although localization of pain, initial or late, in the lower abdomen may lead one to suspect the jejunum. In the exploration of the abdomen for such a perforative catastrophe, and in the presence of this fulminating or chemical peritonitis, the jejunum, and particularly its first portion, should not be overlooked when nothing is found in the stomach or duodenum.

The diminution or absence of liver dullness due to the presence of air over the diaphragm, while difficult to elicit, may support the diagnosis of a perforated ulcer.

Laboratory Findings.—Few of the reported cases included blood counts. One or two, in the presence of peritonitis following perforation, had a blood count between 18,400 and 20,000 white blood corpuscles per cubic millimetre.

The fractional gastric analyses have tended to show a low or absent free hydrochloric acid by the fractional gastric test meal. The case reported had

no free hydrochloric acid by the test meal. The cases of Schmilinski,⁶² Walton,⁷⁴ and Smith⁶⁷ were similar. Ravdin's⁵³ case, on the contrary, had a satisfactory curve for both the free and total acid determinations.

Röntgenological Findings.—Gastro-intestinal studies would appear to be extremely valuable. In the reported case, the ulcer was definitely localized in the jejunum, and, still further, to about six inches beyond the duodeno-jejunal flexure. This means of investigation was employed in all of the non-perforating ulcers. Only one other study (Ravdin⁵³) showed the location of the ulcer. It was only recognized after one exploratory operation had been performed. A review of the films made before the first operation showed the defect.

All one could except from the röntgenological examination would be a regurgitation of the opaque medium (fluoroscopical) into the bowel proximal to the ulcer, actual distension of the proximal loops in the presence of obstruction, and demonstration of a narrow constricted lumen at the site of stenosis. Schmilinski's⁶² and Murphy's⁴⁵ cases had obstructive incompetence of the stomach and duodenum. Smith's⁶⁷ case presented ulcer symptoms and was examined four months prior to the time his ulcer perforated. The gastro-intestinal series showed only spasticity in the abdomen.

There is no anatomical reason why the X-ray (fluoroscope) would not be extremely valuable as an aid in the diagnosis of perforation. Its use has been clearly demonstrated in the determination of air under the diaphragm in the presence of perforation of duodenal and gastric ulcers. Although the jejunum is retro-omental, air, with the patient in the upright position, will find its way to the domes of the diaphragm. This means of demonstrating perforation is extremely valuable. When air is observed, the diagnosis of perforation is definite. This method for the demonstration of escaped air is more accurate than the determination of an altered liver dullness since one cannot know just what size the patient's liver was before observation and onset of symptoms.

In eighteen of the perforated ulcers which came to operation, the pre-operative diagnosis was recorded in fourteen. In seven of these a diagnosis of a perforated gastric or duodenal ulcer was made. In three a diagnosis of appendicitis was offered; in one, intestinal obstruction, and in the remaining three, an unexplained peritonitis. In the seven non-perforated ulcers, a correct diagnosis was recorded but in one case, the reported one. The other six were variously diagnosed as duodenal ulcer, intestinal obstruction, while in two cases diagnosis was uncertain.

Treatment.—The perforated ulcer demands immediate surgery. The possibilities of medical treatment in the chronic ulcer which makes itself manifest by pain or obstruction are practically nil, although, from autopsy reports, it would appear that some people can go many years without being aware of this disease.

In the group without perforation, resection of the ulcer-bearing portion of the jejunum was the operation of choice. Because of the possibility of

malignancy, and especially in the presence of enlarged mesenteric glands, resection is imperative.

In the group with perforation, the ulcer was found and directly attacked in seventeen cases. In ten of these, the area of the ulcer was merely oversewed and the abdominal cavity drained. Six patients survived. In two, the area was oversewed and a posterior gastroenterostomy performed. One lived. In five, resection and lateral anastomosis were performed. Four survived. With but two exceptions, drainage of the abdominal cavity was carried out in the last two groups. In that group in which resection was done, the four patients that survived had all been operated on within twenty-four hours.

Mortality Statistics.—Twenty-five of the forty-two collected cases succumbed, giving a total mortality of 59.5 per cent. Death occurred in only one case in which the ulcer had not perforated. There were thirty-five cases of perforated ulcer, 83.3 per cent. of the total collected cases. Apparently perforation occurs relatively more frequently in the jejunal ulcer than in gastric, duodenal, or gastrojejunal ulcers. Of 368 duodenal ulcers observed in the surgical department of the University Hospital from 1921 to 1932, only forty-eight were perforated, 13.1 per cent. Wright,⁷⁶ reporting 135 secondary jejunal or gastrojejunal ulcers, observed perforation in thirty-one, 22.9 per cent. Bolton and Trotter⁶ reported that 10 per cent. of these ulcerations perforated into the big gut. For anatomical reasons this does not occur with the primary jejunal ulcer.

Twenty-four of the patients with perforated ulcers died, giving a total mortality for this group of 68.5 per cent. This is strikingly high when compared with the total mortality of the above-mentioned series of perforated duodenal ulcers, 25 per cent. In the group with perforation, eighteen (52.8 per cent.) were operated upon, the ulcer discovered, and one of the reparative procedures carried out. Seven of this group died, giving an operative mortality of 38.8 per cent. If those cases were included in which, because of wrong diagnosis, needless operative procedures were carried out, and the one in which the site of perforation was not found, the operative mortality of the cases with perforated ulcers would be higher. The figure for the operative mortality in the perforated duodenal ulcer group was 23.9 per cent.

As in the surgery of the perforated gastric or duodenal ulcer, the earlier operative intervention is instituted, the lower the mortality in these cases of perforated jejunal ulcers. While two of those patients survived whose perforated ulcers were operated upon within forty-eight hours, the remaining nine were operated upon within twenty-four hours.

ADDITIONAL CASES OF PRIMARY JEJUNAL ULCERATION NOTED AT AUTOPSY OR OPERATION FOR SOME OTHER COMPLAINT. NO HISTORY

Mayo Clinic,²⁷ nine cases (unconfirmed).

Schoo,⁶³ one case at autopsy.

Schoo,⁶³ one case at autopsy.

Murphy,⁴⁵ one case at operating table.

Askanazy,² one case pathological report.

Rotgans,⁶⁹ one case during operation for gastric ulcer.

SUMMARY AND CONCLUSIONS.—(1) Primary jejunal ulceration is a disease of rare occurrence whose clinical importance and significance depends upon a relatively high total mortality.

(2) The recognition of simple ulceration of the jejunum depends upon the history of dyspepsia and gastric distress with symptoms not unlike those of peptic duodenal ulcer and, occasionally, of subacute upper jejunal obstruction.

(3) The location of the ulceration may be determined by serial X-ray studies of the gastro-intestinal tract.

(4) The majority of primary jejunal ulcers manifest themselves by acute perforation.

(5) The diagnosis of perforated ulcer of the jejunum may be made from the history of a sudden onset of pain with fulminating signs and symptoms of peritonitis, whether or not there was a previous ulcer history.

(6) The use of the X-ray (fluoroscope) is recommended for its value in the demonstration of air under the dome of the diaphragm in the presence of a perforated jejunal ulcer as it is for a similar perforation of a duodenal or gastric ulcer.

(7) The earlier the surgery in the presence of perforation, the lower the mortality. Pain or obstructive symptoms with localization of the lesion to the jejunum should be treated surgically.

(8) Resection, when possible, is the operation of choice, and most imperative when mesenteric nodes are enlarged.

BIBLIOGRAPHY

- ¹ Arkin, Aaron: Jour. Chicago Path. Soc., vol. viii, p. 224, 1909.
- ² Askanazy, from von Talke: Bruns. Beitr. z. klin. Chirurg., vol. xxxviii, p. 785, 1903.
- ³ Barber, W. Howard: ANNALS OF SURGERY, vol. lxxxiv, p. 621, 1926.
- ⁴ Black, J. M.: Brit. Jour. Surg., vol. xvii, p. 338, 1920.
- ⁵ Bolton, C.: Quart. Jour. Med., vol. v, p. 420, Oxford, 1912.
- ⁶ Bolton, C., and Trotter, W.: Brit. Med. Jour., vol. i, p. 757, 1920.
- ⁷ Brigidi, V.: Gazzetta degli Ospedali, vol. xiv, p. 1434, 1893.
- ⁸ Brown, K. Paterson: Edinburgh Med. Jour., vol. xxxi, p. 45, 1924.
- ⁹ Bryan, R. D.: Surg., Gynec., and Obst., vol. xxii, p. 270, 1916.
- ¹⁰ Cade, *et al.*: Progres. med., vol. xxiv, p. 309, 1913.
- ¹¹ Chiasserini: Ann. Ital. di Chir., vol. i, p. 973, 1922.
- ¹² Cornioley, C.: Rev. med. d. l. Suisse rom., vol. ii, p. 91, 1930.
- ¹³ Cruice, John M.: Am. Jour. Med. Sci., vol. cxlii, p. 683, 1911.
- ¹⁴ de Castlenau: Arch. gen. de Med., vol. ii, p. 74, Paris, 1843.
- ¹⁵ Dickinson, W. Houship: Trans. Royal Med. and Chir. Soc., vol. lxxvii, p. 111, 1894.
- ¹⁶ Dodson: Brit. Med. Jour., vol. i, p. 718, 1906.
- ¹⁷ Elman, R., and Hartmann, L.: Arch. Surg., vol. xxiii, p. 889, 1931.
- ¹⁸ Fischer, A. W.: Virchow's arch. für path. anat. und physiol., vol. i, p. 234, 1921.
- ¹⁹ Fischer, Herman: ANNALS OF SURGERY, vol. lxxvii, p. 775, 1923.
- ²⁰ Fraenkel, E.: Virchow's Arch. für. path. anat. und physiol., vol. excix, p. 131, 1910.
- ²¹ Friedman, G. A.: Jour. Am. Med. Assn., vol. lxxi, p. 1543, 1918.
- ²² Friele, J.: Medicinsk. Revue, 1894.
- ²³ Gale, S. S.: Jour. Am. Med. Assn., vol. lxxix, p. 1047, 1922.
- ²⁴ Grassman, Max: Arch. f. klin. Chir., vol. cxxxvi, p. 449, 1925.
- ²⁵ Hartglass, M.: Bull. et mem. Soc. nat. de Chir., vol. liv, p. 1091, 1928.
- ²⁶ Holtzweissig, M.: Zentralblatt f. Chir., vol. xlix, p. 864, 1922.

- ²⁷ Jancke, C. E.: *Zentralblatt für Chir.*, vol. lvi, p. 1222, 1929.
- ²⁸ Jankowski, J.: *Deutsches Med. Woch.*, vol. xxxiv, p. 2267, 1908.
- ²⁹ Jankowski, J.: *Deutsches Med. Woch.*, vol. xxxvi, p. 126, 1910.
- ³⁰ Judd, E. S.: *Surg., Gynec., and Obst.*, vol. xxxiii, p. 120, 1921.
- ³¹ Karsner, Howard T.: *Human Pathology, a text-book*. J. B. Lippincott Co., Philadelphia, 1926.
- ³² Kirmission, E.: *Bull. Mem. Soc. Chir.*, vol. xxiv, p. 279, Paris, 1898.
- ³³ Krauss: *Med. Cor. Bl. d. Wurttemberg, Arztl. ver. Stuttg.*, vol. xiv, p. 319, 1844.
- ³⁴ Kretschmer, Julian: *Deutsch. Med. Woch.*, vol. xlvi, p. 69, 1920.
- ³⁵ Kronlein, R. V.: *Arch. f. klin. Chir.*, vol. xxxiii, p. 507, 1886.
- ³⁶ Lazerevic, V.: *Deutsch. med. Woch.*, vol. xlv, p. 123, 1919.
- ³⁷ Leotta, N.: *Arch. Ital. chir.*, vol. i, p. 349, 1919.
- ³⁸ Lemierre, A., and Levesque, J.: *Bull. et Mem. Soc. Med. Hospitaux*, vol. xlvi, p. 877, Paris, 1922.
- ³⁹ Lett, Hugh: *Clin. Jour.*, vol. xxv, p. 173, London, 1909.
- ⁴⁰ Mann, Frank C.: *Jour. Exp. Med.*, vol. xxiii, p. 203, 1916.
- ⁴¹ McLaughlin, C. W.: *Amer. Jour. Med. Sci.*, Preliminary Report, 1932.
- ⁴² Nicholson, G. W.: *Jour. Path. and Bact.*, vol. xxvi, p. 399, 1923.
- ⁴³ Moore, Charles: *Lancet*, vol. ii, p. 373, 1864.
- ⁴⁴ Morrin, F. J.: *Irish Jour. Med. Sci.*, sixth series, p. 198, 1931.
- ⁴⁵ Murphy, John B.: *Surg. Clin. of Chicago*, vol. v, p. 435, 1916.
- ⁴⁶ Obendorfer, Siegfried: *Virchow's Arch. für path. anat. und physiol., und für klin. med.*, vol. clix, p. 179, 1900.
- ⁴⁷ Pauchet, from Leotta, N.: *Arch. Ital. Chir.*, vol. i, p. 349, 1919; and from Schilling, H.: *Norsk. Mag. f. Laegvid*, vol. iii, p. 249, 1928.
- ⁴⁸ Papin, Felix: *Jour. de Med. de Bord.*, vol. ciii, p. 146, 1926.
- ⁴⁹ Parenski, Stanislaus: *Med. Jahrbuche*, p. 275, 1876.
- ⁵⁰ Perroud: *Soc. des Sciences Med. de Lyon*, vol. vi, p. 3, 1867.
- ⁵¹ Pesce, M.: *Policlinico*, vol. xxxii, p. 367, 1925.
- ⁵² Pickhardt, Otto C.: *ANNALS OF SURGERY*, vol. xci, p. 291, 1930.
- ⁵³ Ravdin, I. S.: *ANNALS OF SURGERY*, vol. lxxxv, p. 873, 1927.
- ⁵⁴ Renon, L.: and Blatmoutier, P.: *Bull. l'Acad. Med.*, vol. lxxxv, p. 715, Paris, 1921.
- ⁵⁵ Reverdin: *Bull. et mem. Soc. anat. de Paris*, vol. xii, p. 597, 1867.
- ⁵⁶ Richardson, E. P.: *Surg., Gynec., and Obst.*, vol. xxxv, p. 1, 1922.
- ⁵⁷ Roeder, C. A.: *Arch. Surg.*, vol. iii, p. 623, 1921.
- ⁵⁸ Rosenow, E. C.: *Surg., Gynec., and Obst.*, vol. xxxiii, p. 19, 1921.
- ⁵⁹ Rotgans, J.: *I. congr. de la soc. intern. de Chir.*, p. 121, Bruxelles, 1905.
- ⁶⁰ Ruz, E.: *Gazette med. de Paris*, vol. xi, p. 673, 1843.
- ⁶¹ Schilling, H.: *Norsk. mag. f. Largvid*, vol. iii, p. 249, 1928.
- ⁶² Schmilinski: *Muenchen med. Woch.*, vol. lvii, p. 1616, 1910.
- ⁶³ Schoo, from P. H. Van Roojen: *Arch. f. klin. chir.*, vol. xci, p. 381, 1909.
- ⁶⁴ Sestier: *Bull. et mem. Soc. Anat. de Paris*, vol. iii, p. 33, 1827.
- ⁶⁵ Simmons, J. S., and von Glahn, W. C.: *Jour. Am. Med. Assn.*, vol. lxxi, p. 2127, 1918.
- ⁶⁶ Simpson, F. O.: *Practitioner*, vol. lviii, p. 165, London, 1897.
- ⁶⁷ Smith, Beverly C.: *Personal communication*. To be published.
- ⁶⁸ Stokes, J. H.: *Modern Clinical Syphilology, a text-book*. W. B. Saunders, Philadelphia, 1926.
- ⁶⁹ Stone, E.: *Surg., Gynec., and Obst.*, vol. xxxvii, p. 51, 1923.
- ⁷⁰ Sweet, Buckman: *Arch. Surg.*, vol. vi, p. 837, 1923.
- ⁷¹ Taylor, A. S.: *Guy's Hosp. Reports*, vol. xi, p. 282, 1865.
- ⁷² Velte, H.: *Zentralblatt f. Chir.*, vol. li, p. 135, 1924.
- ⁷³ Wagner, E.: *Arch. f. physiol. Heilkunde*, vol. ii, p. 280, 1858.
- ⁷⁴ Walton, A. J.: *Brit. Jour. Surg.*, vol. x, p. 152, 1922.
- ⁷⁵ Weiss, A.: *Zentralblatt für d. grenzgeb. de Med. und Chir.*, vol. v, p. 577, 1902.
- ⁷⁶ Wright, G.: *Brit. Jour. Surg.*, vol. vi, p. 390, 1918.

THE RESULTS OF MEDICAL AND SURGICAL TREATMENT OF PEPTIC ULCER *

BY ROBERT K. FELTER, M.D. AND SYDNEY WEINTRAUB, M.D.
OF NEW YORK, N. Y.

FROM THE DEPARTMENT OF SURGERY AND GASTRO-ENTEROLOGY OF THE CORNELL CLINIC

THE purpose of this study is to evaluate the results obtained with the medical and surgical treatment of peptic ulcer. Although the number of cases studied is comparatively small (fifty-two medical cases and fifty-two surgical cases), nevertheless, this series has particular value because of the length of time that these cases have been under observation and because of the thoroughness of the follow-up study. Each patient was personally interviewed and fluoroscoped by the authors; radiographs were also made and interpreted by Dr. John R. Carty, Chief of the X-ray Department of Cornell Clinic.

The medical treatment employed has been ambulatory, consisting of a modified Sippy diet with olive oil before meals and milk and crackers between meals. One-half to one dram of alkaline powder (equal parts of magnesium carbonate, sodium bicarbonate and bismuth subcarbonate) is taken one hour after meals. In some cases tincture of belladonna, and sedatives such as bromides and phenobarbital, are used. At the start of the treatment the patient is encouraged to report every week or two; the diet is discussed thoroughly; the importance of regulating his mode of living is emphasized and the teeth, tonsils and sinuses are treated when indicated. Thereafter, the patient reports once in three months, adhering to the strict diet from three to six months; after this, the diet is increased, allowing a choice of meats and coarser fruits and vegetables. The milk between meals is continued indefinitely. The alkalization is gradually reduced after three to six months. The patient is fluoroscoped and radiographed every six months.

The immediate response to this form of treatment is very gratifying. In a week or two, the vast majority of patients become free of pain, enthusiastic about the diet and believe a cure is in store for them. However, in judging the results of any form of ulcer treatment, the time element is of utmost importance. The first year or two give very good results, but the third, fourth and fifth years show an increasing number of recurrences. In this series the length of time the cases were studied is as follows:

Although the medical cases have been followed for a longer period of time, it will be noted in Table I that 88.5 per cent. of the surgical cases have been studied over four years and we believe that a fairly accurate comparison of the results can be made between the two groups.

* Read before a combined meeting of the Section of Surgery, New York Academy of Medicine, and the New York Gastro-enterological Association, April 1, 1932.

FELTER AND WEINTRAUB

TABLE I

| Length of Time under Observation | Medical | | Surgical | |
|-------------------------------------|--------------|----------|--------------|-----------|
| | No. of Cases | Per Cent | No. of Cases | Per Cent. |
| 3-4 years..... | 0 | | 6 | 11.5% |
| 4-5 years..... | 0 | | 12 | 23% |
| 5-6 years..... | 24 | 46% | 18 | 34.5% |
| 6-7 years..... | 14 | 27% | 11 | 21% |
| Over 7 years..... | 14 | 27% | 5 | 10% |
| Shortest time..... | 5 years | | 3 years | |
| Longest time..... | 9 years | | 9.25 years | |
| Average time..... | 6 years | | 5.3 years | |

The response to the request to return for examination was elicited in 13 per cent. of the medical cases and in 75 per cent. of the surgical cases. This bears out the experience of others and in the words of Emery and Monroe, who have put it very aptly: "The patient with ulcer is notoriously of a wandering disposition. He goes from one physician to another in search of a cure. A return of symptoms leads him to consult some one else, who may understand his case better. The new advice is often different from the old, and is again accompanied by the assumption that rigid adherence to the new régime will be followed by permanent results. This causes an unsatisfactory state of affairs. The physician is led to believe that his treatment has been efficacious, since the patient does not return. The patient loses confidence."

The average length of time that the medical cases were treated at the Clinic before they discontinued the treatment was two and one-half years; the shortest period one month; the longest six and one-half years; thirty-two cases were treated under two years. These figures show the difficulty in following these patients. They usually discontinue treatment at the end of two years believing that they are cured.

In the surgical group the average duration of medical treatment before operation was 6.5 months. The longest period of treatment before operation was thirty months. Nineteen cases received no medical treatment but were operated on immediately for indications such as obstruction of the pylorus, perforation or penetration.

TABLE II

Age of Patients on Admission

| | Medical | Surgical |
|------------------|------------|------------|
| 10-20 years..... | 0 | 1 |
| 20-30 years..... | 15 | 7 |
| 30-40 years..... | 15 | 23 |
| 40-50 years..... | 16 | 17 |
| 50-60 years..... | 6 | 5 |
| Youngest..... | 23 years | 17 years |
| Oldest..... | 59 years | 57 years |
| Average age..... | 37.5 years | 37.7 years |

PEPTIC ULCER TREATMENT RESULTS

It will be noted that the average age in both groups is practically the same and agrees with the statistics of others; also, that the majority of ulcers occurred in middle life, between the ages of thirty and fifty.

Sex.—In this series there were eighty-three males and twenty-one females, bearing out the well-known fact that the disease is much more common in the male.

Duration of Symptoms at the Time of Admission

| | Medical | Surgical |
|-----------------------------|----------|-----------|
| Shortest duration | 10 days | 30 days |
| Longest duration | 27 years | 34 years |
| Average duration | 5 years | 5 8 years |

Both groups show practically the same average of duration which again emphasizes the chronicity of this disease.

TABLE III

Types of Ulcer

| | Medical | Surgical |
|------------------------------------|---------|----------|
| Post-pyloric | 43 | 45 |
| Parapyloric | 5 | 0 |
| Pyloric | 1 | 0 |
| Gastric | 3 | 6 |
| Post-pyloric and gastric | 0 | 1 |

The duodenal ulcers predominate, there being 88 per cent. as against 9.6 per cent. of gastric ulcers. These figures correspond to the findings in the entire ulcer group at the Cornell Clinic.

TABLE IV

Symptomatology

| Symptoms | Medical | Surgical |
|--|---------|----------|
| Pain in the epigastrium | 49 | 47 |
| Pain in the right upper quadrant | 0 | 2 |
| Pain in the left upper quadrant | 3 | 2 |
| Pain in the lower abdomen | 0 | 1 |
| Awakened at night with pain | 30 | 22 |
| Vomiting | 10 | 31 |
| Hematemesis | 2 | 9 |
| Pain relieved by food and alkalies | 52 | 51 |
| Periodicity | 52 | 52 |

In analyzing the above symptoms, we note that all the patients except one complained of pain in the upper abdomen, and in 92.3 per cent., the pain was located in the epigastrium. Also that in all the cases except one, relief was obtained with food and alkalies. Periodicity was present in all of the cases.

We believe that this triad of upper abdominal pain relieved by food and alkalies with periods of remission from symptoms is the important diagnostic sign of peptic ulcer. In all our cases there was either positive X-ray or surgical pathological evidence of ulcer.

FELTER AND WEINTRAUB

TABLE V
Previous Abdominal Operations

| | Medical | Surgical |
|---|---------|----------|
| Chronic appendicitis..... | 2 | 6 |
| Acute appendicitis..... | 0 | 4 |
| Perforation of ulcer (one case perforated twice)..... | 1 | 2 |
| Excision of ulcer..... | 0 | 1 |
| Kidney stone..... | 1 | 0 |
| Cholecystectomy, appendectomy and exploratory gastrotomy..... | 0 | 1 |

It is a striking fact that 20 per cent. of the cases in this series have had operations previous to admission and after the onset of their ulcer symptoms and that of these, seven had had laparotomies without discovery of the real cause of their symptoms.

TABLE VI
Indications for Operation

| | Post-pyloric Ulcer | Gastric Ulcer | Post-pyloric and Gastric Ulcers |
|---------------------------|-----------------------|------------------|------------------------------------|
| Obstruction..... | 9 | 2 | |
| Persistent symptoms..... | 29 | | |
| Unknown..... | 5 | | |
| Perforation..... | 3 | | |
| Penetration..... | | 3 | 1 |
| Bleeding..... | 1 | | |
| Suspected malignancy..... | | 1 | |

It will be noted that in twenty-nine of the surgical cases (55.7 per cent.) the indication for operation was the persistence of symptoms. We have found that the medical régime of ulcer with its frequent feedings and frequent medication cannot be adhered to by a certain class of patients such as the mechanic, clerk or laborer. Surgery surely offers these people a greater measure of relief and is economically more practical. This will be shown later by our results.

TABLE VII
Types of Operation

| | Post-pyloric Ulcer | Gastric Ulcer | Post-pyloric and Gastric Ulcer |
|--|-----------------------|------------------|-----------------------------------|
| Gastroenterostomy..... | 32 | 1 | |
| Polya..... | 5 | 4 | |
| Billroth, No. 2..... | 3 | 1 | |
| Gastroenterostomy and resection of ulcer..... | 1 | | |
| Simple suture..... | 2 | | |
| Plastic..... | 1 | | |
| Resection of gastric ulcer and plastic on pylorus..... | | | 1 |
| Gastroenterostomy and cautery..... | 1 | | |
| Horsley..... | 1 | | |

The preponderance of gastroenterostomy in this series is due to the fact that most of the ulcers were post-pyloric and it is our opinion as well

PEPTIC ULCER TREATMENT RESULTS

as that of most conservative surgeons that this is the operation of choice in this condition. In a previous communication (Hartwell and Felter) it was shown that these cases were operated upon by a large number of different surgeons at many different clinics, that the mortality in this group of cases was only 2 to 3 per cent. and that the results were extremely satisfactory.

TABLE VIII
Results of Treatment

| | Medical | | Surgical | |
|---------------------|--------------|-----------|--------------|-----------|
| | No. of Cases | Per Cent. | No. of Cases | Per Cent. |
| Satisfactory..... | 10 | 19 | 42 | 80 |
| Improved..... | 8 | 15 | 5 | 10 |
| Unsatisfactory..... | 34 | 66 | 5 | 10 |

The results have been placed in three categories:

(1) *Satisfactory*.—In this category we placed patients who have been free from pain for three years or longer, who are eating everything and have no digestive disturbances. In this group there were ten medical cases, two of which were gastric ulcers and eight post-pyloric ulcers. The average freedom from symptoms was 4.2 years. The X-ray findings in these cases showed the two gastric ulcers to be completely healed and one of the post-pyloric ulcers failed to show a filling defect. The rest of the cases showed filling defects of the duodenal cap.

In the surgical group that proved satisfactory there were thirty-five duodenal ulcers, six gastric ulcers and one gastroduodenal ulcer.

(2) *Improved Cases*.—Under this heading we have placed those cases which are not complaining of pain but still have digestive disturbances and are compelled to follow a strict ulcer régime with alkalies.

In this group there were eight medical cases. One had a return of symptoms in four and one-half years, another had a severe hæmorrhage after four years of freedom from symptoms.

In the surgical group there are five cases considered as improved. Although these patients do not complain of the pain previous to operation, still they have more or less digestive disturbance and are compelled to follow strict diets.

(3) *Unsatisfactory Cases*.—In this group are placed the patients who have not improved or in whom the symptoms have become worse.

In the medical series, there are thirty-four cases. They are still having pain at frequent intervals. Radiographically, the lesions appear either the same or have increased in size. A certain number have developed adhesions. Some of the ulcers which formerly were confined to the duodenum only are now involving the pyloric and pre-pyloric regions. There was one case of gastric ulcer which returned after a five-year period of freedom from symptoms. There were five cases of duodenal ulcer in which symptoms returned five years later. There were two cases which showed the importance of the radiographical examination in the follow-up study of ulcer.

At the initial examination they both revealed a pyloric ulcer with a twenty-four-hour retention of barium; they refused surgical treatment at that time. They returned five years later claiming to be free from symptoms and eating everything but the recent radiographical examinations reveal the same pyloric lesion with a twenty-four-hour gastric retention.

In this group there were also three cases that were operated upon subsequent to our initial examination; the surgeon thought that the ulcer was healed and nothing more was done to relieve the ulcer. These three patients still have the same symptoms and the same ulcer is seen radiographically.

In the surgical group there were five unsatisfactory cases. One of these developed a gastric ulcer after having been free of symptoms for four and one-half years after gastroenterostomy for duodenal ulcer. Two cases had recurrence of severe hæmorrhage following operation. One case which had had a duodenal ulcer excised was still having recurrent attacks of severe pain seven years after operation. Another case was having all her old symptoms five years after a subtotal resection for duodenal ulcer, although there was no evidence of ulcer on the radiographical examination.

Comment.—From the study of the foregoing figures, the conclusion can be reached that the ambulatory treatment is a poor method of treating ulcer. The question might then be raised whether or not other forms of medical treatment would offer better results. Our personal experience with other forms of treatment has been limited but the medical literature contains valuable records of comparison. Blackford and Bowers reported on twenty cases receiving the Sippy hospital treatment with 60 per cent. satisfactory results and sixty cases receiving ambulatory treatment with 58 per cent. satisfactory results. They concluded, however, as follows: "Hospital treatment almost always brought immediate relief; but as time elapsed we found that many patients had a return of trouble, in spite of every care and advice that we could give them regarding diet and medication. We were forced to the opinion that it was doubtful whether these favorable cases (with three or four weeks in the hospital behind them and a year or more of extreme care afterward) did better than those on casual ambulatory treatment."

Einhorn and Crohn in 1926 reported on 100 cases which had received the hospital treatment on a modified Sippy régime. On a follow-up of twenty-two cases for four years, they report a cure in only 27.3 per cent.

Although there is a variation in the results reported by many observers, nevertheless the majority report poor results with all forms of medical treatment of ulcer, depending largely on the length of time elapsed that the cases are followed. This is excellently summarized by Einhorn and Crohn as follows: "Thus, Friedenwald, after five years of follow-up survey, reports 74 per cent. of 'cured or improved,' Greenough and Joslin only 52 per cent. for a similar group and period. After two to thirteen years of follow-up, Russell reported 27.7 per cent. cured and 15 per cent. improved, and after a ten-year follow-up, Delmasure could find only 14 per cent. cured and 23 per cent. improved. These figures from the literature

PEPTIC ULCER TREATMENT RESULTS

are surprising and far from reassuring for the ultimate outcome of medical treatment of ulcer of the stomach or duodenum.

As is well known, there is considerable controversy as to the relative merit of medical and surgical treatment of ulcer. In order to arrive at some definite conclusions on this subject, we have attempted the above study emphasizing the importance of a personal follow-up over a long period of time including comparative radiographical studies. We feel that a questionnaire follow-up in the above series would have led us to erroneous conclusions. Many of the surgical cases have been seen and X-rayed from two to four times after operation, and at least once previous to surgical treatment. The medical cases have received between two to six radiographical examinations.

The results of surgical treatment are all the more striking when it is considered that this group must of necessity have had more severe symptoms than the medically treated cases. At the Cornell Clinic a conservative attitude is adopted toward ulcer patients. Every effort is made to avoid surgical treatment; many cases are hospitalized and receive the Sippy treatment before surgery is finally resorted to. No case is operated upon unless there has been a joint consultation between the gastroenterologist, surgeon and radiologist.

CONCLUSIONS.—(1) One hundred and four cases of peptic ulcer were followed on an average of 5.6 years, fifty-two treated medically and fifty-two treated surgically.

(2) Of the cases treated medically, 19 per cent. were satisfactory. Of the surgically treated cases, 80 per cent. were satisfactory.

(3) Of the medically treated cases, 15 per cent. more were improved. Of the surgically treated cases, 10 per cent. more were improved.

(4) The results were unsatisfactory in 66 per cent. of the medically treated cases and 10 per cent. were unsatisfactory in the surgically treated group.

BIBLIOGRAPHY

- Blackford, and Bowers: *Amer. Jour. Med. Sci.*, vol. mclxxxii, p. 51, 1929.
Einhorn, and Crohn: *Amer. Jour. Med. Sci.*, vol. mclvi, p. 695, 1926.
Emery, and Monroe: *Arch. Int. Med.*, vol. xliii, pp. 846-873, June, 1929.
Hartwell, and Felter: *ANNALS OF SURGERY*, pp. 602-615, October, 1930.

CLINICAL AND PATHOLOGICAL FACTORS INFLUENCING ULTIMATE PROGNOSIS FOLLOWING RESECTION FOR CARCINOMA OF THE STOMACH

BY HOWARD K. GRAY, M.D.

OF ROCHESTER, MINN.

FROM THE MAYO CLINIC *

BECAUSE of refinements in diagnostic procedures and because the span of life is increasing, a relative increase in the incidence of malignant lesions has been noted. To the lay mind this has signified an increase in the incidence of carcinoma and has contributed to the uneasiness already existent. The impression has been disseminated that any recognized therapeutic measure is utterly futile, and on this information rests the financial success of the innumerable "cancer cures," the majority of which are based on the local application of a paste or other substance. In event the malignant process is confined to an internal organ where the beneficial effects of the external application might be doubted, an increased feeling of hopelessness is produced. This is the state of mind in which the victim of a malignant process of the stomach finds himself. The futility of orthodox treatment has been impressed on him by the ultraconservative prognosticator and he has despaired of more than palliation. The facts show, however, that in a large group of cases excellent results have followed surgical removal of malignant lesions of the stomach. Infrequently, the surgical procedure was supposedly undertaken for palliation only, and the patient has lived in good health for ten years or more.

My purpose in presenting these data is twofold: First, to place on record the more favorable aspect of surgery of the stomach for malignant lesions; 273 cases are considered in which resection of the stomach was done in The Mayo Clinic for carcinoma and the patients lived five years or longer. This group has been divided into two subgroups: (1) 145 patients who when last heard from had lived between five and ten years (62 per cent. of these were still living), and (2) 128 patients who had lived ten years or longer. Second, to consider in detail the clinical and pathological factors that might have some bearing on the ultimate outcome in similar conditions. To evaluate properly such data as might exist, a third group of 100 cases was selected in which resection of the stomach had been done at The Mayo Clinic for carcinoma, and the patients had died from the malignant process within twelve months. Those who had died from other causes were excluded. The results of this study are presented.

Method of Study.—In the 373 cases which comprised the three groups, the specimens were removed between January 1, 1907, and December 31,

* Abridgement of thesis submitted to the faculty of the Graduate School of the University of Minnesota. Submitted for publication August 17, 1932.

PROGNOSIS RESECTION STOMACH CANCER

1924. With the exception of a few unusually interesting specimens that had been mounted for museum exhibit, the material had been preserved in formalin solution; other material had been cut so extensively by previous investigators that further study was impossible. Such omissions have been noted. Each specimen was subjected to gross examination, its situation, size, and general characteristics were noted, and a block was cut from the body of the tumor for microscopical study and grading. The frozen and paraffin sections were stained in the usual manner with hematoxylin and eosin. The presence or absence of lymphatic involvement had been determined previously by the pathologist, who received the fresh specimen from the operating room, and it was necessary to accept this report without further study, owing to the futility of obtaining accurate information concerning specimens that had been preserved for so long a time.

The clinical data were obtained by personal study of all records and data as supplied by the record department of the clinic.

All specimens were graded prior to personal supervision and correction by Broders, and the classification of grades was made according to his method. The cases have been divided for study into three groups: group 1, cases in which patients died within twelve months after operation (100 cases); group 2, cases in which the patients lived five years or longer after operation (145 cases) and group 3, cases in which the patients lived ten years or longer (128 cases).

The ratio of men to women (3:1) followed quite closely that noted by other observers. There was a slight increase in incidence among women of group 1.

It is commonly believed that virulence of a malignant process, all other factors being equal, varies in inverse proportion to the age of the patient. Although the difference in the average age of those who survived ten years (groups 2 and 3) and those who died within twelve months (group 1) was only one and nine-tenths years, the patients in groups 2 and 3 were younger. Because of the qualifying statement, "all other factors being equal," no exception could be made in this case with regard to the virulence of the malignant process noted in the cases in question. It was noted that the percentage incidence by decades showed remarkable consistence in the three groups, and that no reliable prognostic criteria could be deduced from this source. (Fig. 1.)

Contrary to what might be expected, a lower percentage of family histories of malignancy occurred among the patients of group 1 than in either group 2 or group 3.

The clinical histories in the 373 cases revealed that three distinct clinical entities can be recognized easily. In most of the cases (approximately 75 per cent.) symptoms had persisted without remarkable change except gradual increase in severity for a varying length of time. Not infrequently a rather typical ulcer syndrome was described, but more often the distress consisted of vague and bizarre digestive distress as Eusterman and others have em-

phasized. Such symptoms had persisted for from less than three months to twenty-five years, but in most cases they had not been present prior to a year before the patient was operated on. In another series of cases (approximately 25 per cent.) symptoms had been referable to the stomach for varying lengths of time, but a recent change or additional symptom other than a slight gradual increase in severity had been noted. It was because of this change that the patients sought relief. A negligible percentage of patients comprising the third series had not experienced symptoms suggesting a gastric lesion, and the carcinoma of the stomach was found accidentally.

An attempt was made to determine in an impartial manner the length of time during which the malignant process had made itself manifest. It seemed logical to assume that the process would be rather consistent for all patients irrespective of group (as determined arbitrarily by the length of

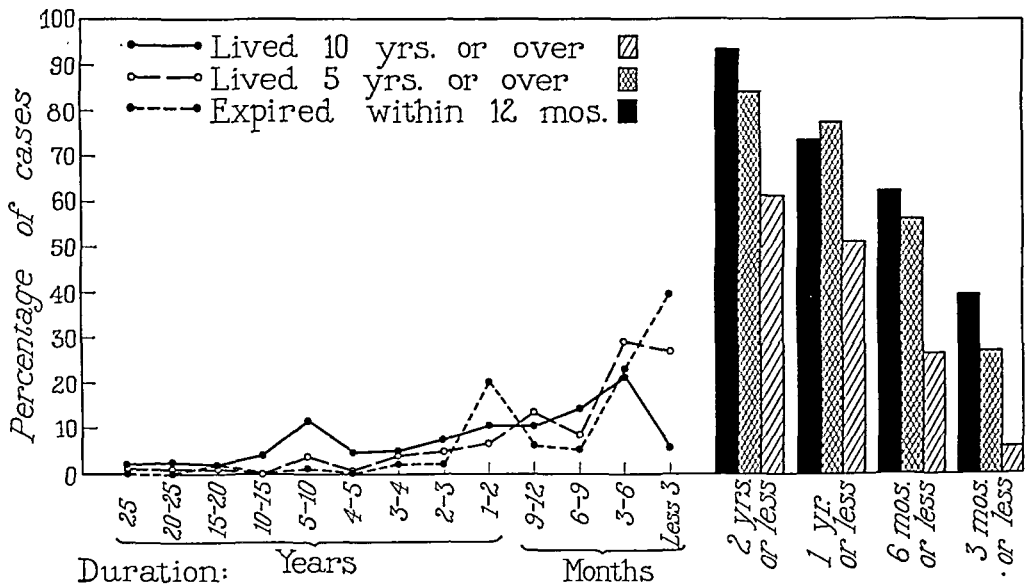


FIG. 1.—Percentage of cases by groups in relation to the duration of symptoms.

post-operative life), and that all would endure an equal amount of distress before seeking medical attention. The most accurate estimate that could be obtained, therefore, consisted in evaluation of the length of time the patients had had symptoms for which they sought relief. (Fig. 1.) Consistently, the patients who lived for a considerable number of years after resection of the malignant process had had symptoms longer than those who died within twelve months. Two explanations for this are possible: either the process was progressing more rapidly, or because of some unknown peculiarity it had progressed so far silently that when symptoms finally occurred cure was no longer possible.

The average loss of weight in the three groups varied only by 0.4 pounds. The general condition of the patient, as evidenced by this factor, was much the same in all groups, but it may be noted that the patients who died within a year had had symptoms which averaged a shorter duration.

PROGNOSIS RESECTION STOMACH CANCER

The average percentage value of the hæmoglobin prior to resection was 9.8 points higher in group 1 than in groups 2 and 3. The chronic character of the lesions must have played a part in this determination.

The percentage incidence of cases relative to gastric retention was charted. Uniform amounts of retention were recorded and the curve showed remarkable consistence.

Hartman and Sager* have shown that anacidity prior to resection is associated with twice the chance of five years' post-operative life than if free hydrochloric acid could be demonstrated. In the cases under consideration anacidity was present in 68.8 per cent. of patients who died a year after operation (group 1). In 49.5 and 47.5 per cent. of patients who lived more than five and ten years, respectively (groups 2 and 3), it was impossible to demonstrate free acidity.

In all groups most of the lesions occurred in the antrum, although they were observed approximately one-fifth more often in this locality in cases of group 1 than in cases of groups 2 and 3. Conversely, a malignant process on the lesser curvature of the stomach was twice as common in groups 2 and 3, whereas malignant tumors on the anterior wall, posterior wall, and greater curvature were almost equally common.

The average size of the lesion was determined, not by the size relative to situation, but by comparing the average size of the lesion in the three groups. The tumor with the most discouraging prognosis was the smallest in the three groups.

The sessile type of tumor with a broad flat base which projected into the lumen of the stomach occurred with almost equal incidence in all groups. Evidence that perforation is of grave prognostic significance is shown by the fact that this had taken place seven to eight times as often in group 1 as in groups 2 and 3. Ulceration, on the other hand, was seen in only 8 per cent. of the cases in group 1 as compared with 37.9 and 35.9 per cent. in groups 2 and 3. (Fig. 2.)

As was to be expected, lymphatic involvement occurred more frequently in the group in which death occurred early. It was noted in from 41.7 to 49.3 per cent. more cases in group 1 than in groups 2 and 3. (Fig. 3.) Such involvement relative to the site of the lesion was of minor significance.

Little can be added with regard to involvement of the serosa to what has been noted regarding involvement of the lymph-nodes. Involvement of the serosa was of grave prognostic significance, as it was observed 46.4 per cent. more often in cases of group 1 than in those of group 2, and 65.9 per cent. more often in cases of group 3. (Fig. 4.)

Carcinoma of the stomach, graded 1, is relatively uncommon. The high incidence of recurrence following resection of malignant gastric lesions in general can be attributed to this fact. The greatest incidence of the lowest grade of malignancy occurred in cases of group 3. The incidence in these

* Hartman, H. R., and Sager, W. W.: A Statistical Study of the Diagnostic Value of Anacidity. *Med. Jour. and Rec.*, vol. cxxiv, pp. 96-97, July 21, 1926.

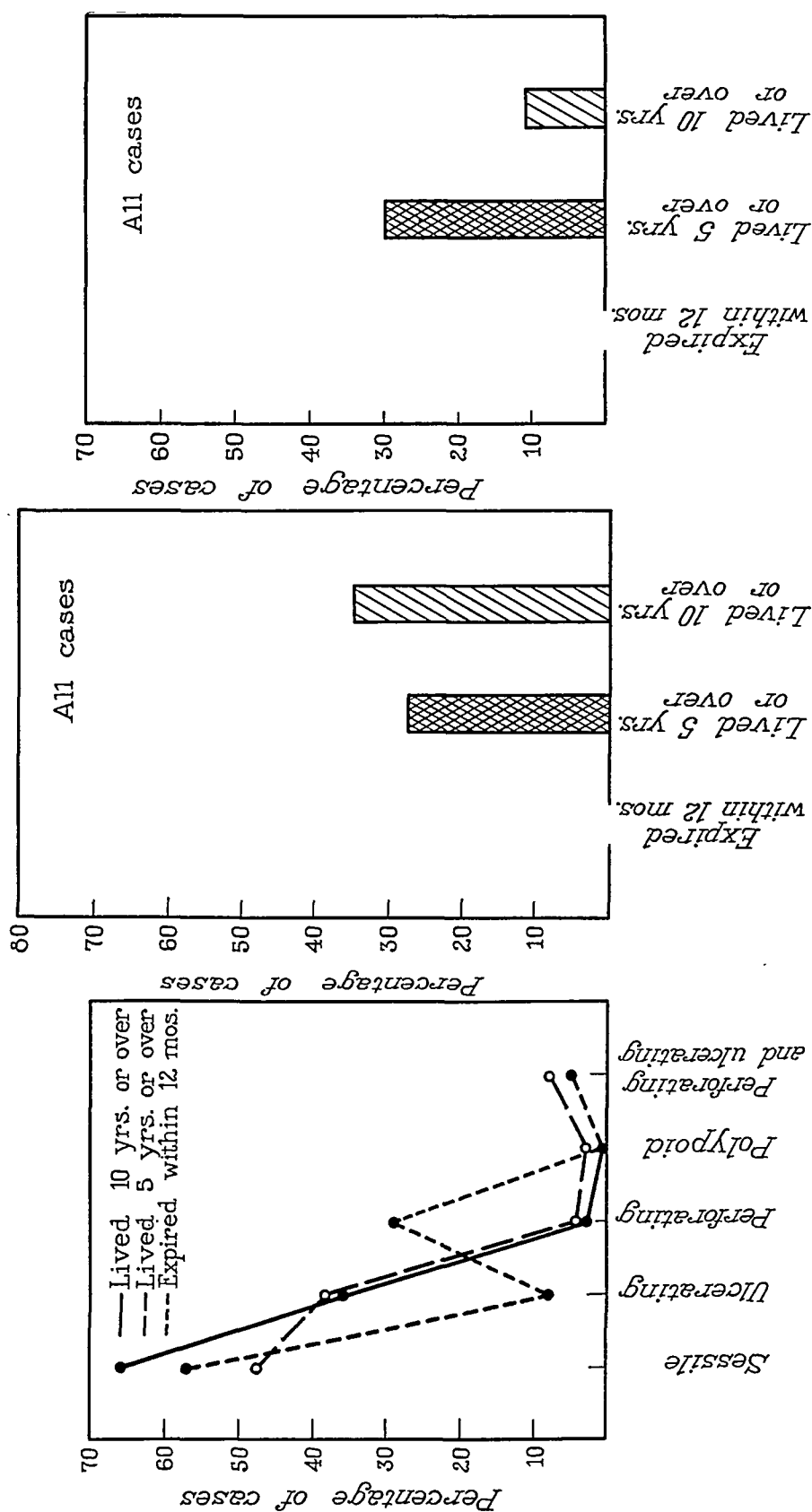


Fig. 2.—Percentage of cases by groups in relation to Fig. 3.—Percentage of cases by groups with lymphatic involvement. Fig. 4.—Percentage of cases by groups with involvement of the serosa.

PROGNOSIS RESECTION STOMACH CANCER

cases increased in direct proportion to the length of post-operative life. This was also true in cases of malignancy, graded 2, which comprised only 8.2 per cent. of the cases in group 1. Seventy-one and four-tenths per cent. of the patients in group 1 had involved regional lymph-nodes as compared with 35.4 and 40.0 per cent. in groups 2 and 3. Lesions graded 3 and 4 exhibited exactly the opposite phenomenon; the incidence decreased in direct proportion to the length of post-operative life. (Fig. 5.) Involvement of the lymph-nodes occurred in 72.7 and 84.4 per cent. in cases of group 1, 26 and 25 per cent. in cases of group 2 and 44 and 66 per cent. in cases of group 3, in the same grades. In other words, involvement of the lymph-nodes occurred less frequently in the higher grades of malignancy in cases in which patients lived five years or more after operation than it did in cases in which patients were unable to withstand the process longer than one year.

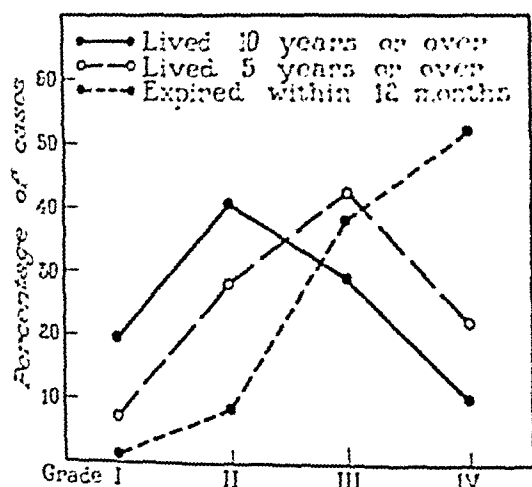


FIG. 5.

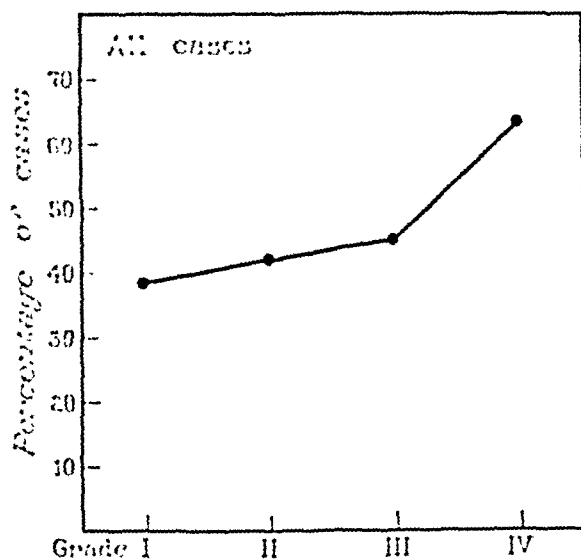


FIG. 6.

FIG. 5.—Percentage of cases by groups in relation to the grade of the lesion.

FIG. 6.—Percentage of all cases with lymphatic involvement in relation to the grade of the lesion.

SUMMARY AND CONCLUSIONS.—Three hundred seventy-three cases in which resection of the stomach had been done for carcinoma at The Mayo Clinic were studied. The cases were divided into three groups: (1) 100 cases, in which patients did not survive longer than twelve months after operation; (2) 145 cases, in which the patients had lived more than five years when last heard from, and (3) 128 cases, in which patients had lived longer than ten years after operation.

The groups were studied as separate entities in an effort to determine the clinical and pathological factors that might influence the ultimate prognosis. The pathological data, with the exception of grading of malignancy, was based on the total number of cases. Due to the fact that ninety-two specimens had been preserved permanently for museum exhibition, or had been cut previously to such an extent that further study was impossible, blocks for microscopical examination and grading were obtained in 281 cases.

An analysis of results suggests certain positive and negative conclusions

relative to the clinical and pathological factors that influence the ultimate prognosis following resection of the stomach for carcinoma.

From a clinical standpoint, sex, age, familial history of malignancy, and attempts to determine the general condition of the patient as evidenced by loss of weight and measurements of the total quantity of gastric content are inconclusive so far as prognosis is concerned.

Features of positive clinical prognostic significance depend, first, on a careful determination of the duration of symptoms. A short history of a gastric lesion in the age group included in this study is a grave prognostic omen, since it suggests a rapidly progressing process. This impression is strengthened by the fact that the average hæmoglobin value was seen to be higher in these cases than in those in which a relatively chronic disease was in progress. The presence of anacidity must be considered with some apprehension.

From a pathological standpoint no prognostic factors can be elicited from the situation of the lesion, with the obvious exception that resection is technically possible with average operative risk.

The fact that the average size of the lesions in the group in which prognosis is less favorable (group 1) was smaller than the groups in which post-operative life was more than five years (groups 2 and 3) is further evidence to support the fact that the disease has been present for a shorter period. An ulcerating growth tends to render the prognosis less grave, whereas a perforating growth adds to the seriousness of the situation.

The three most important factors that decrease the possibility of a long post-operative life are involvement of the lymph-nodes and the serosa, and a tumor of high-grade malignancy. Because the incidence of involvement of the lymph-nodes increased in direct proportion to the increase in severity of the malignant process as indicated by the grade, the last-named feature should be considered the most important single factor.

INFLAMMATORY TUMORS OF THE GASTRO-INTESTINAL TRACT

By JOHN H. MORRIS, M.D.

OF NEW YORK, N. Y.

FROM THE FOURTH SURGICAL DIVISION, BELLVAUE HOSPITAL

THE significance of simple inflammatory tumors of the gastro-intestinal tract seems to have been first pointed out by Moynihan,¹ in 1907, when, in an article entitled *Mimicry of Malignant Disease in the Large Intestine*, he stated that during the course of the three preceding years he had operated upon six tumors of the large intestine under the mistaken impression that he was dealing with examples of malignant disease. In all these cases, the clinical manifestations and macroscopical appearances supported this opinion but minute examination of specimens removed or the subsequent history of the case proved that the disease was in every instance of non-malignant character. In 1908, Robson² discussing *Some Abdominal Tumors Simulating Malignant Disease* expressed the opinion that the simple inflammatory tumor of the intestine was relatively common, that it presented one of the most difficult problems in abdominal diagnosis and, in confirmation of both contentions, cited numerous illustrative cases from his records. About the same time Proust,³ in France, and Braun,⁴ in Germany, contributed similar experiences. The former resected the transverse colon for a tumor whose pre-operative diagnosis was carcinoma or tuberculosis while the latter removed from the sigmoid a mass which he believed to be a carcinoma. In each instance these original diagnoses were supported by the classical symptoms of large-gut malignancy, *viz.*: loss of weight, bleeding, colic, obstruction and operative exposure of the pathology merely disclosed gross evidence confirming this conception. Upon further study of the specimens, however, it was noted that both exhibited features which clearly differentiated them from the carcinomata. In the first place, it was apparent macroscopically that instead of originating in the mucosa as do the carcinomata, these masses appeared to have their inception in the mesocolon whence they had invaded the gut walls secondarily. Microscopically, the tumors were made up largely of poorly nucleated connective tissue with new blood-vessel formation, perivascular round-cell infiltration and many leucocytes. The mucosa was well preserved and there was no histological proof of malignancy, necrosis or abscess formation. Both these observers regarded this tumor as a definite disease entity which in the absence of careful histological analysis would usually be mistaken for carcinoma whose gross and clinical aspects it so accurately simulated. They therefore attempted to identify this structure by the adoption of an appropriate terminology "Pseudo-tumor" (Braun) and "Para-intestinal Tumor" (Proust).

The publication of the foregoing reports awakened a new interest in the routine analysis of large-gut tumors with the result that, during the subse-

quent few years, an increasing number of these cases appeared in the literature of England and on the Continent. In our own country, however, recognition of this type of tumor has not been general and, with few exceptions, our literature and texts have completely ignored this subject. Notable among these exceptions are the publications of Moscovitz and Wilensky,⁵ in 1923, and Mock,⁶ in 1931.

The former gathered from various hospitals of New York City four interesting examples of this condition for which they proposed the term "Non-specific Granuloma of the Intestine." In all four cases there was a dense uncircumscribed mass involving all coats of the large intestine causing stricture of the lumen. In three cases the ascending colon was involved and, in the fourth, the splenic flexure. In one case the main bulk of the tumor projected into the mesentery whereas in the remaining three the infiltrating process was most prominent in the gut wall. Superficial ulcerations were noted in the mucosa but in general this layer was intact and fairly well preserved.

In all these specimens a fairly uniform microscopical morphology was revealed. All coats of the intestine were densely infiltrated by a fibroblastic process which varied from a cellular and apparently fresh granulation tissue with many newly formed blood spaces to a comparatively dense fibrous structure. This tissue appeared in the submucosa but infiltrated the muscle to such an extent as to cause extensive distortion and separation. The round cell was predominant throughout. In one case numerous giant cells were found and, in another, an area of polymorphonuclear infiltration justified the term "abscess."

Of the ten cases reported by Mock, three involved the omentum, three the stomach, one the ileum and three the large-gut-cæcum, splenic flexure, sigmoid. In all except the omental tumors, gross inspection at operation led to the definite diagnosis of neoplasm and frozen sections made at this time on the splenic flexure and the cecal tumors were respectively reported as round-cell sarcoma and carcinoma. In all these cases further histological study disclosed the familiar picture of chronic inflammation and the subsequent clinical course eventually confirmed the diagnosis. To designate this type of tumor this writer proposed the term "Infective Granuloma" as appropriately expressive of the character of the process and assembled a convincing array of histological opinion in support of this usage.

These facts open up interesting possibilities for the consideration of both pathologist and clinician. The histological picture encountered in this condition is frequently perplexing when its gross characteristics are borne in mind and occasionally leads to erroneous pathological diagnoses. In two of Mock's cases, frozen section was responsible for classifications of sarcoma and carcinoma while specimens exhibiting giant cells have been grouped under tuberculosis. Interest in these tumors is not, however, limited to their histological aspects. To the clinician, the concept of the pseudo-malignant inflammatory tumor of the intestinal tract is an invaluable resource in the

precise determination of therapy and prognosis of abdominal tumors. Robson observed a man of fifty-five years who presented a tumor of the ascending colon associated with classical symptoms of malignancy. Several years previously this patient developed a similar mass which disappeared spontaneously under observation. This history supplemented by the fact that the mass appeared to be rather fixed and extensive influenced the institution of conservative methods with the result that tumor and symptoms disappeared completely in six months. In Braun's case a diagnosis of carcinoma of the cæcum was made in 1895, but the patient refused to submit to operation. In 1908, this patient was operated upon for gall-bladder disease and careful exploration of the cæcum at this time disclosed no trace of the original tumor. Robson mentions five cases in which colostomy was done for supposed inoperable malignancy of the rectum or sigmoid and in every instance the mass had entirely vanished in periods varying from one to three years. The same writer observed three other interesting large-gut tumors for which short-circuit operations were done. In the first, an aged man, an inoperable tumor of the transverse colon was found; in the second, a male of seventy years, a large mass of the ascending colon causing acute obstruction and in the third a chronically obstructing tumor of the splenic flexure. In all three cases entero-anastomoses were performed as a palliative measure and, in spite of what appeared to be a hopeless prognosis, these patients were in good health from one to three years later. Robson remarks that it is this type of tumor with its presumably hopeless prognosis and the miraculous return to health which has established patent medicines and the charlatan. By the same token this condition not infrequently humiliates and discredits the surgeon who encounters but fails to recognize its significance and concludes his exploration with dogmatic predictions of an early mortality.

The problems, clinical and pathological, presented by the simple inflammatory tumors together with the relatively meagre consideration devoted to them in our own country furnish the justification for the following report of an excellent example of this condition:

CASE I.*—A Mexican, twenty-eight years of age, was admitted to Fourth Surgical Division July 1, 1929. A few days before admission he had noted a dull steady pain localized to right lower quadrant accompanied by nausea but no vomiting. Appetite was fairly good but bowels did not move for first three days in spite of strong cathartics taken. The pain became progressively more severe and at night he complained of chill, fever and headache. He had lost ten pounds in weight during the ten days preceding his admission. There was no history of bloody stools, urinary disturbances or radiation of pain. His health previous to present illness had been good and there was no history of malaria, typhoid or previous intestinal disorders. He had never had a chronic cough, hemoptysis or venereal infection and had never been operated upon.

Examination disclosed a well-nourished and well-developed male of twenty-eight years. Temperature on admission was 100.6°, pulse 88, and respiration 20. Soon after admission he had a chill lasting one hour, during which temperature reached 103.2°. Urinalysis negative; white blood-cells, 9,200; polymorphonuclears, 78 per cent.; smear negative for malaria. Red blood-cells, 4,700,000. Wassermann negative (post-operative

* Reported before New York Surgical Society, January 12, 1932.

report). The heart was normal. At the apex of the right lung coarse râles were heard. The abdominal muscles were relaxed and there was no distension. In the right lower quadrant a hard, slightly tender, freely movable mass about the size of a large orange was felt. Rectal examination disclosed no abnormalities and the extremities were negative. Pupillary and tendon reflexes reacted normally.

Operation.—In view of the evidences of impending obstruction the patient was operated upon without further X-ray study. Exploration of the abdomen revealed a firm, fairly well circumscribed mass which appeared to originate in the hepatic flexure of the colon whence it seemed to extend into the mesocolon of the hepatic angle. The gut was angulated about the tumor in such a way that the lumen of the former was



FIG. 1.—Photograph of gross specimen, Case I, showing (a) tumor at mesocolic angle; (b) angulation of hepatic flexure; (c) normal mucosa in opened transverse colon.

almost obliterated. The gall-bladder was adherent to the mass and the regional lymph-glands were quite definitely enlarged. A gross diagnosis of carcinoma of the hepatic flexure was made and a radical resection to include the right half of the transverse colon and 10 inches of the distal ileum was done. Mobilization of the large gut disclosed many enlarged lymphatics and marked oedema of the retroperitoneal space. For this reason a side-to-side isoperistaltic anastomosis was carried out and the abdomen closed without drainage.

With the exception of a deep infection of the lower angle of the wound, the patient made an uncomplicated recovery. The wound was completely healed on the nineteenth post-operative day and he was discharged in good condition. During the ensuing several

INFLAMMATORY TUMORS OF INTESTINES

months this patient was followed in the return clinic and was observed to gain rapidly in weight and strength. Soon thereafter he left the country and has since been lost sight of but when last seen was enjoying good health.

Gross Examination of Specimen.—The ileum and appendix are normal. A firm, fairly well circumscribed mass occupies the angle formed by the hepatic flexure. This mass invades the gut walls but its main bulk is seen to be in the mesocolon. The colon is angulated acutely about the tumor so that the colon distal to it appears to fold back on itself to become adherent to the cecum. (Fig. 1.) On section the tumor is avascular, homogeneous and whitish with many small yellow areas. The centre is necrotic and an attached node shows a diffuse hyperplastic surface. Upon opening the lumen of the angulated colon it was noted that, although the muscular wall was definitely infiltrated, the mucosa was everywhere normal in appearance, there being no evidence of ulceration, thickening, diverticulum or other pathological change. The

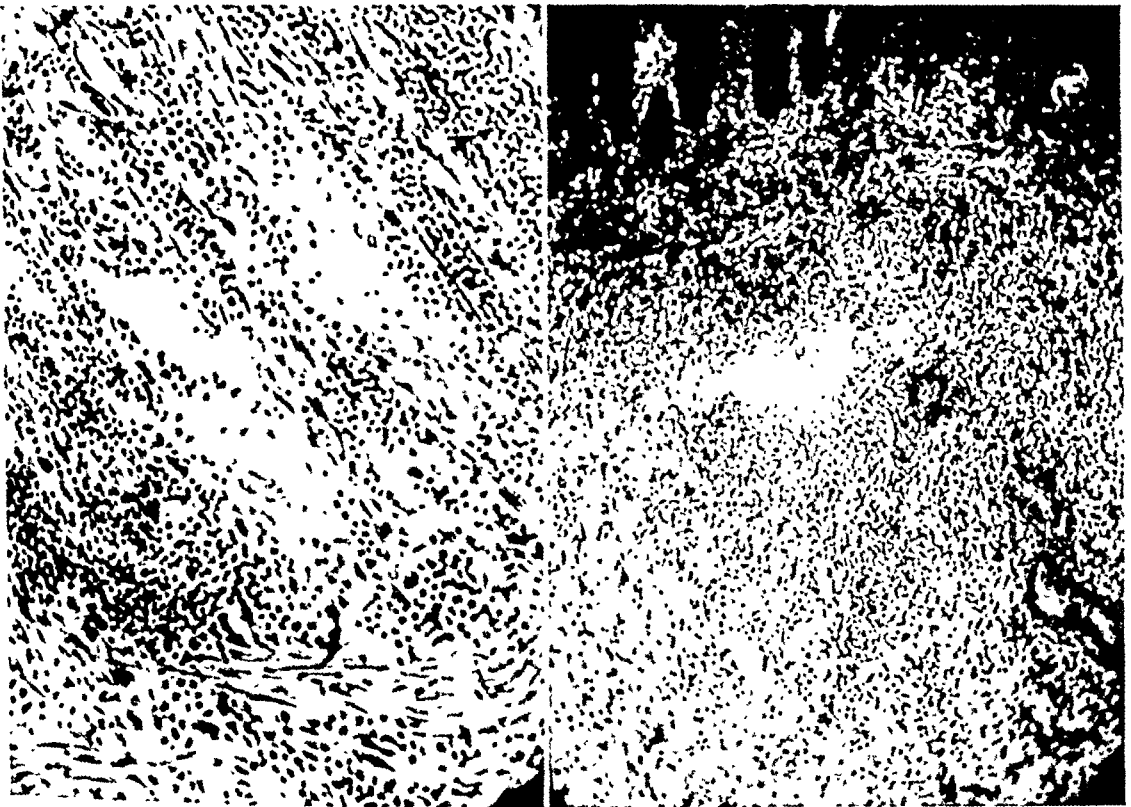


FIG. 2.

FIG. 3.

Fig. 2.—Subserous section from Case I, showing typical picture of granulation-tissue tumor.
Fig. 3.—Submucosal section to show sharp limitation of inflammatory process at muscularis mucosæ.
tumor was subsequently serially sectioned in search of foreign bodies with negative results.

Microscopical Report by Dr. Douglass Symmers.—"Section into the necrotic area shows many polymorphonuclears and necrotic tissue. Outside this, there is new granulation tissue. The rest of the area consists of granulation tissue with many eosinophiles. There is no evidence of tuberculosis or neoplastic tissue. *Diagnosis.*—Chronic productive inflammation with areas of suppuration. Probably healed or healing abscess."

Sections of this tumor were made at various levels in order to determine histologically the relationship of the process to the various elements of the gut walls. Figure 2 represents a subserous section and shows granulation tissue rich in round cells and fibroblasts infiltrating the muscular layers. Round cells predominate the picture against a scattered background of fibroblasts. There are also numerous polymorphonuclears, eosinophiles and mast cells while here and there mitotic figures may be seen. Section through the mucosa and submucous tissues (Fig. 3) shows the inflammatory process

extending up to the muscularis mucosa, which seems to act as a barrier against further extension. Beyond are seen normal intestinal glands which do not participate in the process. A high power of this region discloses the same histological characteristics noted in other sections. No giant cells or foreign bodies could be found in this specimen.

It seems reasonable to conclude from the gross and microscopical evidence presented by this particular case that the process arose primarily from an extra-intestinal focus. The location of the major portion of the mass in the mesocolon, the progressive, but secondary, infiltration of the gut wall fading out at the muscularis mucosæ and, finally, the absence grossly and microscopically of pathological changes in the mucosa itself all lend support to this contention. This conception of the origin of these tumors is of considerable interest in view of the existing theories of their etiology.

Senn⁷ is authority for the suggestion that tumor growths of this type derive their original impetus from interference with the local blood supply of a given tissue. As a consequence there follow necrosis and low-grade infection which stimulate in the adjacent areas a reactive reparative process. Necrosis, infection and reactive repair proceed hand in hand but the latter eventually predominates with the resultant progressive piling up of granulation tissue until a tumor-like mass is formed.

However this may be in theory, clinical observation points out certain practical etiological factors which appear to predispose to the development of the infective granulomata. These factors have been well classified by Mock under three headings: (1) Conditions existing within the gastro-intestinal tract or its mesentery; (2) extraperitoneal infections which spread to and involve the gastro-intestinal tract; (3) traumata due to surgical procedures or extraneous injury.

Considering its structure and the physiological demands placed upon it, the mucous membrane lining of the large intestine at once falls under suspicion as a logical source of inflammatory processes involving the gut wall and adjacent tissue. This mucosal area is constantly exposed to minute traumata, ulceration and infection, the results of which must be concentrated somewhere in the subjacent lymphatic or vascular drainage areas. Simple ulcers resulting from the trauma by a harsh intestinal content, ulcerative colitis or even an infinitesimal perforation by foreign body may well be considered as the origin of an inflammatory reaction within the gut wall, its mesentery or both. Perhaps something akin to this sequence of events is exemplified in the tumefactions so frequently associated with diverticulitis of the sigmoid colon. In this condition the characteristic multiple herniations of mucous membrane into and through the muscular coats are inevitably involved in varying degrees of acute or subacute infection. Persistence or recurrence of such process sets up in the adjacent gut wall and its mesentery a reactive inflammatory fibrosis which eventually produces in this region a tumor mass often indistinguishable clinically from the carcinomata. Acquired diverticula of this type, although commonly observed in the sigmoid or descending colon, are occasionally encountered throughout the large and

INFLAMMATORY TUMORS OF INTESTINES

even at times in the small intestine. The suggestion, therefore, that the inflammatory tumors found in these latter localities may arise in this manner is not unworthy of consideration.

The importance of surgical trauma as a causative factor in the production of the granulomata has been repeatedly stressed and the frequency with which these tumors are encountered at sites previously invaded by surgery lends some credence to this assumption. The exact mechanism through which this etiological relationship develops is not, however, entirely clear. It is, of course, well recognized that surgical transgressions of the peritoneal cavity exact certain undesirable penalties inevitably consequent upon (1) mechanical trauma of the peritoneum; (2) the introduction of extraneous foreign material such as ligatures, suture material, drains, *etc.*, and, where the intestinal tract is invaded, (3) the introduction of bacterial infection and foreign material from the intestine. Any or all of these sources of intraperitoneal irritation are undoubtedly capable of exciting a reactive tissue response similar in character to that seen in the infective granulomata. Nevertheless, it is difficult thus to explain the extreme degrees of reaction characteristic of the granulomata unless one attributes to those so affected, a specific susceptibility to these particular stimuli.

In Moscowitz and Wilensky's series of four cases of granulomata, three had previously been operated upon for acute appendicitis, while in the fourth case an attack of acute appendicitis (not operated upon) antedated the tumor formation. Such evidence carries obvious implications but, unfortunately for the traumatic theory, the possible significance of these figures is nullified by the fact the tumors in this group did not invariably develop at or near the site of operation. On the other hand, of infinitely greater importance was the observation in one of these tumors of an unknown foreign body surrounded by giant cells. Jaffe reported an inflammatory tumor of the colon, in the centre of which a small piece of bone was found, and Schreiber described an ulcerating tumor of the cæcum containing in its substance cherry and plum pits. In one of Mock's cases, a granuloma had developed around a linen purse-string suture applied during an appendectomy several months previously.

The following case which is reported through the courtesy of Dr. J. V. Bohrer is of particular interest in this connection:

CASE II.—C. D., a ten-year-old school girl, was admitted to the Children's Surgical Service, Bellevue Hospital, March 25, 1931. Eight months before admission, she had been operated upon elsewhere for acute appendicitis and following this operation a persistent fistula had developed at the lower angle of the incision. She was a well-nourished and developed child whose abdomen presented an indurated right rectus scar. At the lower angle a small fistulous tract admitting a fine probe for a distance of one and one-half inches was found. This area was widely indurated superficially but no intra-abdominal mass could be felt.

Operation.—April 4, 1931, scar excised. Sinus tract followed down to loop of small intestine, excised and base inverted. Rubber tissue drain inserted and abdomen closed.

Patient was discharged May 30, 1931, with wound completely healed and remained

perfectly well until July 15, 1931. At this time, according to history, she received a sharp blow over the site of the incision and one week later lower angle of incision opened and drained intermittently until date of readmission August 3, 1931. At this time, there was noted a well-established sinus at lower angle of wound which was discharging a thin sero-pus. No tenderness or masses detected. Temperature 100.2°.

Operation.—August 10, 1931, abdomen opened through the old scar. The fistulous tract, indurated and well defined, led directly from the abdominal wall to the ileocecal region. At this point, a large, hard mass was found invading the lateral wall of the cæcum and so encroaching upon its lumen as to produce an almost complete obstruction. A wide resection of distal ileum cæcum and ascending colon with subsequent ileocolic anastomosis was carried out.

The patient made an uncomplicated recovery and was discharged from the hospital with wound completely healed by primary union. Follow-up records reveal the fact that she has remained entirely well up to the present time.

On gross examination, the specimen presented a firm, diffuse infiltration of the walls



FIG. 4.

FIG. 4.—Low-power entire-field Case II, showing thickening of serosa and muscular coats with numerous old scattered abscesses.

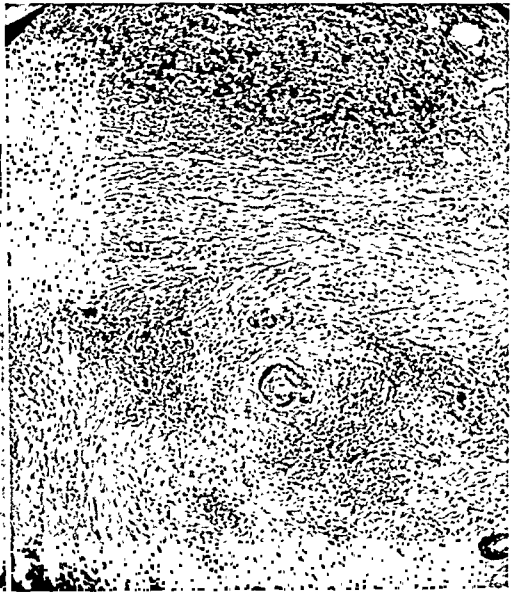


FIG. 5.

FIG. 5.—High-power Case II to show perivascular infiltration and thickening.

of the cæcum and ascending colon. The lumen of the cæcum was almost completely obliterated by compression and constriction. The mucosa itself, however, was normal in appearance and presented no macroscopical evidence of ulceration or thickening. In deference to the conception that tumors of this type and site arising at this age were most commonly tubercular in origin, a gross operative diagnosis of tuberculosis of the cæcum was made at the time. Subsequent microscopical study of sections revealed a dense fibrous-tissue infiltration involving particularly the muscular coats, and, to a lesser degree, the serosa and submucosa. Particular emphasis was placed at this time upon the presence in the gut walls of numbers of thickened blood-vessels, the process of thickening involving all coats but being especially pronounced between the intima and the yellow elastic lamina—the so-called endarteritis obliterans. This lesion, occurring most frequently in syphilis but occasionally seen in chronic productive tuberculosis, suggested sections stained for tubercle bacilli and spirochetæ but in neither instance were specific microorganisms encountered. In view, however, of the frequency of endarteritis

in association with syphilis and because syphilitic lesions of the lower gastro-intestinal tract were said to be more common than tubercular lesions, the operative diagnosis was revised and patient discharged with the final histological diagnosis of syphilis of the cæcum.

The unusual features of this case stimulated subsequently a review of specimen and numerous fresh serial sections were made for its more intensive study. This study revealed in addition to a dense fibroblastic infiltration of muscular and subserous coats (Fig. 4) marked evidence of a chronic inflammatory reaction characterized by round cell and polymorphonuclear infiltration, plasma cells, cosmophiles and œdema. Numerous old punctate abscesses were scattered throughout and in one area a group of giant cells were seen. In view of these findings the process was interpreted as a chronic productive inflammatory process. Inasmuch as endarteritis is not uncommonly found in association with such a process, it is unnecessary to assume a diagnosis of syphilis to account for the presence of this feature. (Fig. 5.) Accordingly, diagnosis was again revised and finally recorded as infective granuloma of the cæcum.

These experiences with Cases I and II together with numbers of similar instances from the literature throw considerable light upon the behavior of the infective granulomata and emphasize the problems encountered in their treatment. The total number of available cases is too small to permit the luxury of dogmatic conclusions but there are discernible throughout this group common and distinctive features which are of fundamental importance to the proper evaluation of these tumors. It is, in the first place, established that under certain conditions a simple chronic productive inflammatory process may express itself as a well-defined tumor mass whose true nature is usually not suspected at the operating table. Furthermore, although these tumors may occur throughout the digestive tract, they show a distinct predilection for that segment which is conceded to be the favorite site for the neoplasms, namely, the large intestine. Finally, they are capable of imitating any or all of the classical subjective symptoms usually attributed to the malignancies. Thus, the clinical manifestations, distribution and gross characteristics of the infective granulomata all combine to present a picture which is interpreted commonly as malignancy; occasionally as tuberculosis; rarely as syphilis. It is therefore not remarkable that these tumors invariably suffer the fate dictated by these misconceptions. Where the mass is susceptible to removal, a more or less radical resection is the rule; if apparently inoperable, the patient is condemned to some palliative procedure supplemented by a hopeless prognosis. In the latter event the subsequent failure of the condition to proceed to the anticipated fatal termination or the actual spontaneous disappearance of the tumor eventually determines a revised diagnosis. In the former, post-operative histological study discloses the first suspicion of the benign character of the growth.

Identification of the infective granulomata is not, however, merely a matter of academic interest for their early differentiation from the malignant tumors will have an exceedingly practical influence upon both prognosis and treatment. As has been previously pointed out, the granulomata present all the gross and clinical characteristics of malignancy or tuberculosis and, in con-

sequence, are commonly subjected under this impression to the unnecessary hazards contingent upon radical resection. On the other hand, clinical evidence bears witness to the fact that inflammatory tumors of the gastro-intestinal tract respond most favorably to conservative surgical methods and that simple short-circuiting of the tumor by means of entero-anastomosis or enterostomy is adequate to secure a complete and permanent disappearance of the pathology; indeed, in some instances, spontaneous resolution of the process has followed laparotomy alone. Since these conservative measures assure not only satisfactory therapeutic results, but also a better prognosis and a negligible mortality rate, it follows that their substitution for more radical methods approximates the ideal in the treatment of the infective granulomata. It is quite obvious, however, that the employment of such methods must be predicated upon the ability to differentiate these tumors pre-operatively or at operation from the malignancies and this constitutes the essential problem of the infective granuloma.

The solution of this problem necessitates a practical method by which the granulomata may be identified at the operating table when decision as to the type of treatment must be made. It is evident, therefore, that while the microscope offers the sole precise method of diagnosis, the data therefrom are available too late to be a determining influence in this decision. The frozen section suggested to meet this deficiency is at best not ideal and when applied to the study of granulation tissue is particularly susceptible to misinterpretation. Indeed, the frequency with which the infective granulomata have been classified histologically as carcinoma, sarcoma, tuberculosis or syphilis indicates that even under the most favorable conditions of study this tissue presents certain diagnostic problems. These errors are undoubtedly attributable to the protean character of granulation tissue with its fibroblasts, lymphocytes, giant cells, endarteritis, *etc.* The predominance of any one of these elements when considered in conjunction with a positive clinical and macroscopical diagnosis may give impressions suggestive of one of the above tumors. Consequently, deliberate and repeated histological studies are often necessary if the infective granulomata are to be consistently isolated from other tumors of the large gut.

These facts direct attention to the possibilities of macroscopical diagnosis and although it is generally conceded that the granulomata do not possess gross features to distinguish them from carcinomata of the colon, a review of the findings in Case I is worthy of consideration in this connection. It will be recalled, for example, that the gross pathology in this case aroused speculation as to its nature even before the histological diagnosis was obtained. While the tumor appeared to involve the intestine at the hepatic angle, it was observed that there was a disproportionate invasion of the mesentery not commonly seen in the malignancies unless far advanced. It was further noted on gross section that the mucosa was not implicated in the process and that the obstructive manifestations were apparently due to encroachment

upon the lumen from without rather than to constriction arising primarily within the lumen. Similar observations have been made in other cases of granulomata and are particularly significant in view of the theory that these tumors have a primary extra-intestinal origin and that invasion of the gut wall follows secondarily. The epithelial tumors arise in the mucosal lining of the gut to produce primary constrictive effects within the intestinal lumen. Peripheral extension to gut wall and mesentery is a later manifestation and unless far advanced is not so prominent as that described in Case I, where the main bulk of the tumor mass was mesenteric in position. Obstruction in the epithelial tumors should therefore result comparatively early from the effect of primary intraluminary constriction. With the granulomata, however, obstruction should theoretically be a late development and is properly to be considered as due to extrinsic pressure of a progressive parain-testinal inflammatory mass. Viewed in the light of the present discussion the macroscopical findings in Case I appear sufficiently distinctive to suggest gross diagnosis of a non-malignant tumor. If it can be demonstrated by further observations that these macroscopical characteristics exist with any degree of constancy in the inflammatory tumors, then macroscopical differentiation with its attendant advantages may become an accomplished fact. Decision on this important point must await increased experience with the infective granulomata.

In conclusion the salient facts relating to infective granulomata of the gastro-intestinal tract may be thus briefly summarized:

(1) Simple, non-specific inflammatory processes associated with the gastro-intestinal tract may, under certain conditions, express themselves in the form of well-localized tumor masses whose favorite site is the large intestine.

(2) Because of the striking similarity in their clinical manifestations, gross pathology and localization, differentiation from the malignancies or tuberculosis is not usually made macroscopically; consequently radical treatment with its attendant mortality rates and prognosis has been the rule.

(3) The response of the inflammatory tumors to simple surgical methods which insure a good prognosis and negligible mortality rates indicates the importance of pre-operative or operative (macroscopical) diagnosis.

(4) Although histological study offers the sole precise method of differentiation, its evidence is too remote to be of practical clinical value.

(5) The findings in Case I suggest the possibility that inflammatory tumors may present macroscopical characteristics which distinguish them from malignancies of the large gut. If it can be determined by further observation that these distinguishing characteristics are in any degree constant, an important contribution to treatment and prognosis is presented.

(6) The fact that the inflammatory tumors are frequently classified clinically and macroscopically as carcinoma, sarcoma, tuberculosis or syphilis, justifies the assumption that they are more common than statistics indicate.

NOTE.—Shortly after the submission of this article for publication the writer encountered and operated upon the following case, the record of which presents interesting evidence tending to support theories advanced in the above discussion relative to the origin and behavior of infective granulomata.

CASE III.—L. S., twenty-three years of age, was admitted as an acute emergency November 29, 1932, to Mary Immaculate Hospital, service of Dr. John M. Scannell. Four years previously while on a trans-Atlantic liner, he was taken acutely with an abdominal attack diagnosed as appendicitis. Owing to rough weather, however, it was decided to treat the condition conservatively and ice-packs were resorted to up to the time of his transfer to Ellis Island Hospital several days after onset of attack. Immediate operation was carried out and, although operative wound was completely healed

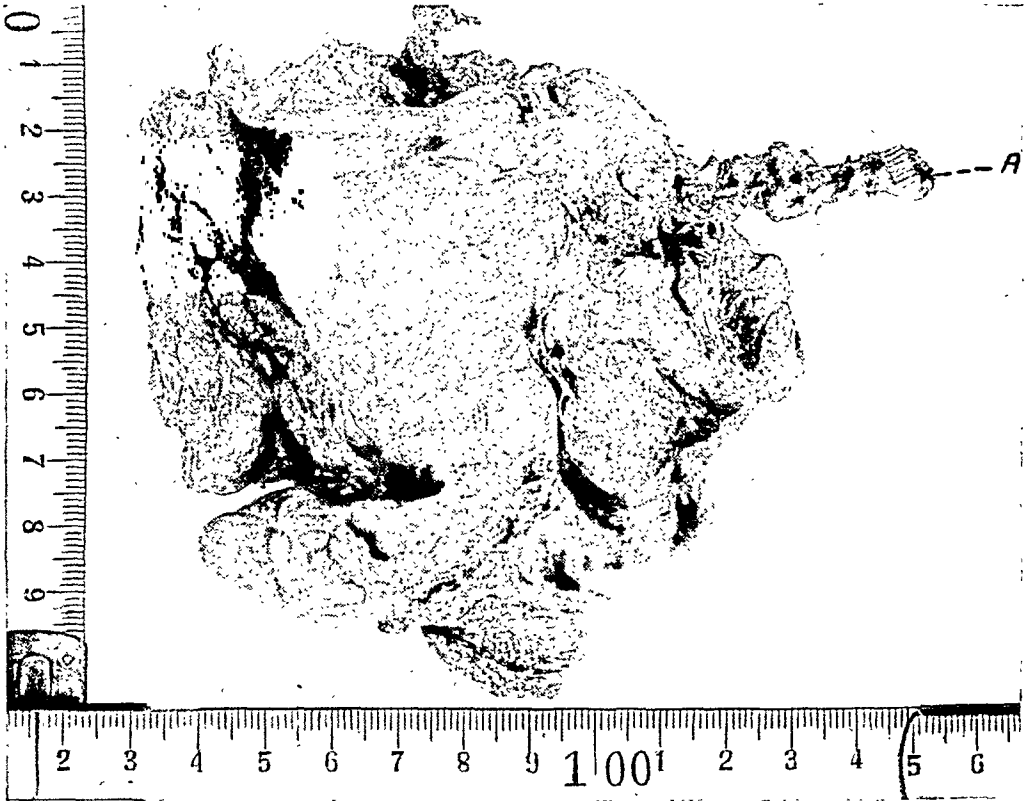


FIG. 6.—Tumor mass with appendix leading into its centre. (A)—Base of appendix.

after two weeks, patient was detained at the hospital for thirteen weeks thereafter because of "blood poisoning." One week after discharge from hospital he was again seized with an acute pain in right lower quadrant of abdomen and was admitted to another hospital where a mass in the right lower abdominal quadrant was incised and drained. The wound continued to drain pus for some time and at intervals he suffered from intermittent cramp-like pains in lower abdomen. There was no associated nausea, vomiting, diarrhoea, constipation or urinary disturbance. One week before admission he was taken with a particularly severe attack of this type and had eventually sought admission to hospital because of the persistence of symptoms.

Examination disclosed a slight, pallid, rather poorly developed male of twenty-three years. His rectal temperature was 103° , pulse rate 120; he was perspiring profusely and appeared to be acutely ill.

The abdomen presented in the right lower quadrant, two scars, one a long right

INFLAMMATORY TUMORS OF INTESTINES

pararectus and the other a short scar in the neighborhood of McBurney's point. The right rectus muscle was rigid throughout, but acute tenderness was localized to right lower quadrant where a firm, fixed mass about the size of a large orange could be detected. Rectal examination was negative except for tenderness to right side of pelvis and in cul-de-sac of Douglass.

The blood count on admission showed 4,380,000 red blood-cells, 15,350 white blood-cells, with 71 per cent. polymorphonuclears. A pre-operative count made a few hours later showed white blood-cells 29,550, with polymorphonuclears 91 per cent.

A pre-operative diagnosis of infective granuloma of the cæcum was made on the basis of history, physical findings and laboratory data.

Operation November 29, 1932.—Right pararectus incision. On opening peritoneum, a large, firm, densely adherent tumor mass was found occupying the angle formed by the cæcum, ascending and transverse colons. This mass seemed to arise from the cæcum but was adherent at various points to the anterior abdominal wall and small gut. At



FIG. 7.—Tumor mass with appendix (A) showing abscess cavity and foreign body (B).

its upper pole an angulated segment of transverse colon was attached and, in the vicinity of this point of attachment, the wall of the large gut presented an area of annular thickening and induration which had encroached upon the lumen sufficiently to produce an acute obstruction. Proximal to this colonic mass the cæcum and ascending colon were greatly dilated whereas distally, the large gut was relatively collapsed. With some difficulty the mass was freed from the abdominal wall, loops of small gut and transverse colon. At the point of attachment to the cæcum, the appendix was found leading into the centre of the mass and at this point a large abscess cavity containing a definite foreign body was disclosed. (Fig. 7.) The entire mass with appendix (Fig. 6) was removed and the obstruction in the transverse colon was short-circuited by means of a colo-colostomy about the obstructing mass. Abdomen then closed after instituting suitable drainage.

Pathological Report (Dr. E. F. Koch).—*Macroscopical Description.*—A mass of tissue with appendix attached measures ten and one-half by twelve centimetres. The distal portion of appendix shows a perforation with a foreign body present and protruding from the lumen. Section of the appendix reveals mucosal proliferation, fibrosis and subserosal hæmorrhage. The serosa of the distal portion is completely

denuded. Section reveals a small lumen, mucosal proliferation and fibrosis. Section through wall appears to be granulation tissue and reveals hæmorrhage and fibrosis with scattered areas of adipose tissue. The centre of this mass appears necrotic.

Microscopical Description.—Sections show appendix embedded in a dense mass of granulation tissue. Appendiceal mucosa show tremendous glandular hyperplasia and infiltration by round cells, plasma-cells and eosinophiles. Dense fibrous mucosal scars which show chronic inflammatory cellular infiltration give evidence of previous acute inflammatory process. Sections of the main mass of tissue show it to consist in its entirety of inflammatory granulation tissue and fibrous tissue in various stages of maturity. There is no evidence of specific inflammation or of malignant neoplasia.

Pathological Diagnosis.—Chronic diffuse appendicitis. Non-specific peri-appendical granuloma.

Post-operative Course.—Convalescence proved to be a bit stormy and some degree of wound infection developed. The patient was, however, discharged from hospital sixteen days after operation with temperature normal, wound healed and free from subjective symptoms. He remained perfectly well until December 20, 1932, or for a period of two weeks after operation. At this time he was readmitted to the hospital complaining of acute epigastric pain and persistent vomiting. The abdomen was generally distended and tender but no masses could be felt. An immediate laparotomy carried out by Dr. M. T. Reynolds disclosed an acute obstruction due to strangulation of a loop of ileum or jejunum by band of adhesions. The stoma established at former operation was found to be patent and functioning but unfortunately there was no note as to the status of the granulomatous mass in colon. The patient made a good recovery following this procedure and was discharged from the hospital December 31, 1932, being eleven days after second operation.

In analysing this case record, the following features should be stressed as pertinent to the foregoing discussion of the infective granulomata.

(1) A correct pre-operative diagnosis based on history and physical findings and confirmed by gross inspection made possible relatively conservative surgical treatment of the obstruction, *i.e.*, entero-enterostomy.

(2) The microscopical characteristics of the process: "inflammatory granulation tissue and fibrous tissue in various stages of maturity."

(3) The macroscopical characteristics of the process: a large solid tumor mass with multiple abscess formation and a definite foreign body at its centre developed on a basis of a recurrent acute appendicitis previously subjected to two operations. (Figs. 6 and 7.)

(4) The secondary extension of the process to the walls of the transverse colon producing an obstructive annular induration suggestive of neoplasm. This feature confirms not only the obstructive potentialities of these tumors but, of greatest significance, establishes the extra-intestinal origin of this particular large-gut granuloma.

BIBLIOGRAPHY

- ¹ Moynihan, B. G. A.: *Edinburgh Med. Jour.*, N.S., vol. xxi, p. 228, 1907.
- ² Robson, A. W.: *Brit. Med. Jour.*, p. 425, February 15, 1908.
- ³ Proust, R.: *Bull. et Mem. Soc. de Chir. de Paris*, vol. xxxiii, p. 1158, 1907.
- ⁴ Braun, H.: *Deutsch Ztschr. f. Chir.*, T; p. 100, 1909.
- ⁵ Moscowitz, E., and Wilensky, A. O.: *Am. Jour. Med. Sci.*, N.S., vol. clxvi, p. 48, July, 1923.
- ⁶ Mock, H. E.: *Surg., Gynec., and Obst.*, p. 672, March, 1931.
- ⁷ Senn, N.: Quoted by Mock.

PRIMARY MUCOID CARCINOMA OF THE RECTUM IN A THIRTEEN-YEAR-OLD GIRL

By THEODORE S. RAIFORD, M.D.

OF BALTIMORE, Md.

AND

E. M. BUTTLES, M.D.

OF BURLINGTON, VERMONT

FROM THE DEPARTMENT OF SURGERY AND SURGICAL PATHOLOGY OF JOHNS HOPKINS HOSPITAL AND UNIVERSITY

ALTHOUGH malignancy of the bowel is prone to attack individuals in the "cancer age," namely, from forty to sixty years, malignant tumors are not infrequently found in young people. In the main, these are sarcomas, but carcinomas may occur. Thus, Cullingworth, in 1877, reported a huge, pedunculated tumor of the pylorus occurring in a ten-day-old infant. This had the general structure of a cylindrical-cell carcinoma, but the author was inclined to regard it as a congenital adenoma. Clar, a few years later, described a medullary carcinoma of the colon in a boy of three years and Duncan reported a carcinoma of the ileum in a boy three and a half years old. Nothern found an adeno-carcinoma of the cæcum in a twelve-year-old boy. Kanthack and Furnival reported a carcinoma of the colloid variety in the ascending colon in a seventeen-year-old male. Garrard reported a similar case in the sigmoid flexure of a twelve-year-old boy. Osler and McCrae collected from the literature six cases of carcinoma occurring in the first and thirteen in the second decade of life. The authenticity of these cases is to be doubted, however, since the authors pointed out that exact diagnosis was questionable. Several cases aged from fifteen to twenty years have been reported. Marble reported a case from this hospital of an adeno-carcinoma in the stomach of a seventeen-year-old girl. The majority of carcinomas have been of the so-called adeno-carcinoma type or of an embryonic variant. Only two cases of the so-called colloid or mucoid carcinoma have been found in the literature occurring in an individual under the age of twenty years.

In an unpublished paper the author has reviewed all of the cases of so-called colloid carcinoma, and differentiated between the primary carcinoma of mucoid-secreting cells and the mucoid deposition accompanying degeneration secondary to adeno-carcinomas. None of the primary mucoid carcinomas occurred in individuals under the age of forty years. The finding of a primary mucoid carcinoma of the rectum with widespread skeletal metastases in a girl of thirteen years has therefore seemed of sufficient importance to justify its publication.

CASE REPORT.—*Path. No. 47148.*—The patient was a white girl thirteen years of age. She was admitted to the Mary Fletcher hospital on the service of Doctor Buttles in October 19, 1931, complaining of severe pain in the lower part of the back. The onset

of the pain followed an injury suffered when she fell against her bed four weeks before admission. On the morning after this injury she had pains in the lower lumbar region which were sharp and continuous. She was unable to walk without assistance. Her attitude in standing was one of flexion and she frequently placed her hand over her hip-joint. On admission to the hospital, her appetite was poor, and she was very restless. Her bowels were regular and required no cathartics. The onset of menstruation was in



FIG. 1.—Röntgenogram of spine, lateral aspect. The first lumbar vertebra is eroded and flattened, causing a moderate dorsal kyphosis. The second is rarefied, but shows no marked distortion. The twelfth thoracic is also eroded on the anterior aspect but as yet shows no flattening.

May of the same year. Her periods had always been regular, but associated with some discomfort. There was nothing significant in her family history, except that eleven brothers and sisters had died in early infancy for which the causes were unknown.

The girl was well developed, but poorly nourished. She was in no acute distress when admitted. The thorax showed a moderate degree of emaciation with prominent bony landmarks. There was increased dullness on percussion over the left base

RECTAL CARCINOMA IN YOUTH

posteriorly. Fine râles were heard over the left apex during inspiration. There were no significant findings in the examination of the abdomen other than tenderness on deep pressure in both lumbar regions. There was marked pain in the right hip-joint on walking. This pain did not radiate. She was unable to flex the spine while in a sitting position. There was a slight lateral angulation in the lower thoracic region. The neurological examination was essentially negative.

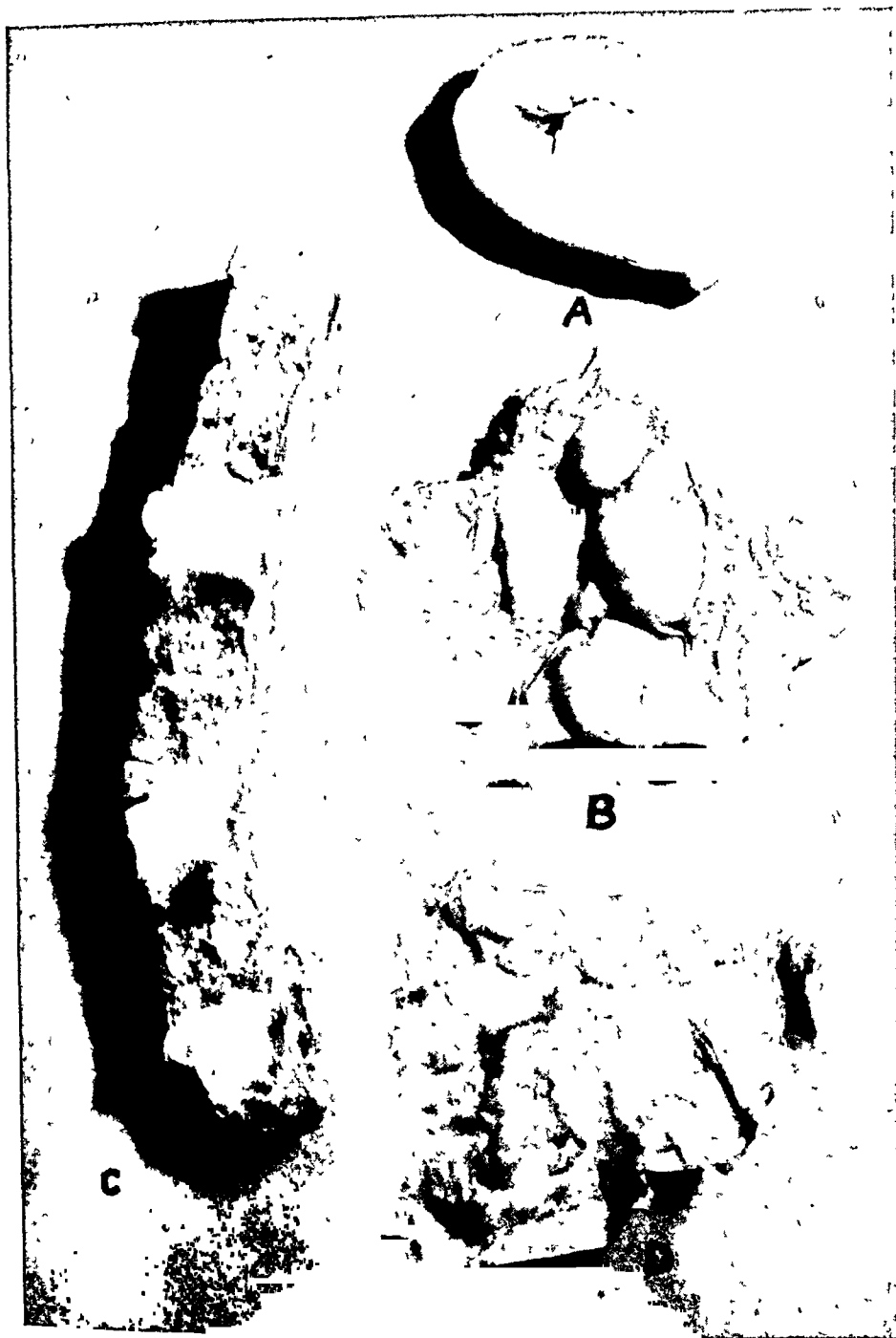


FIG. 2.—Photograph of gross material removed at autopsy. *A*—Cross-section of the rectum showing infiltration of the wall and extension out along the mesentery. *B*—Mass of glands from mesentery near rectal tumor. *C*—Section of lumbar vertebrae, showing partial destruction of bone by secondary tumor deposits. *D*—External aspect of a portion of the dura with tumor implants.

Laboratory Examination.—Blood: 85 per cent.; red blood-cells, 4,150,000; white blood-cells, 5,250; differential count, normal. Urinalysis: A slight amount of albumin and many pus-cells were the only positive findings in the first specimen. These were absent in the second and all subsequent specimens. X-rays of the heart and lungs essen-

tially negative. The lateral and anterior-posterior plates of the spine showed a marked erosion of the first lumbar vertebræ with some flattening of the twelfth dorsal. (Fig. 1.) The condition was temporarily diagnosed tuberculosis of the spine and palliative treatment instituted.

Course in the Hospital.—The patient vomited frequently every day for about a week, and complained of acute pain in the lumbar region. She became constipated and enemas were necessitated for two days, after which cascara was sufficient to sustain catharsis. Four days after admission she was placed in an extension apparatus. The pain continued for several days, then gradually diminished. Several lumbar punctures were performed. The first showed normal pressure, but many red blood-cells. The second showed an increased pressure with no chemical or microscopical abnormalities. The remaining examinations of the spinal fluid were negative. The temperature varied from 99° to 102° during her stay in the hospital. The patient was restless most of the time and continued to vomit at irregular intervals. It was apparent that she was growing

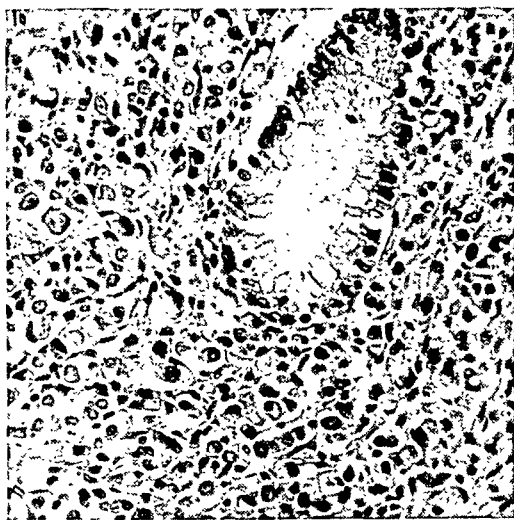


FIG. 3.

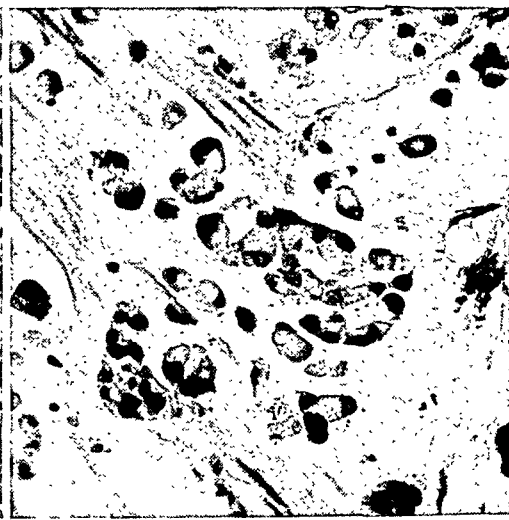


FIG. 4.

FIG. 3.—High-power photomicrograph of a section from the rectum. Note the portion of a crypt that appears unaffected by the tumor. Entirely surrounding it, however, and apparently arising from the epithelium adjacent are many malignant cells growing independently and without semblance of alveolar arrangement. The majority of these are polygonal in shape and variable in size. A few are distended by mucus and the nuclei are pressed to one side. The cells are separated by a fairly well developed stroma.

FIG. 4.—High-power photomicrograph of malignant cells lying deep in the muscular part of the rectal wall. Several have assumed the signet-ring shape and are lying free in deposits of mucus. The muscle fibres are being invaded and destroyed by the tumor.

progressively weaker. The bowels remained open and required no further cathartics. The patient failed rapidly and died November 30, 1931.

Pathological Report.—The autopsy findings were essentially negative except for the gastro-intestinal tract and the skeletal system.

Gross Pathology.—*Rectum:* (Fig. 2A). The rectal wall was thickened, fibrous and indurated, and the lumen was partially occluded. On cut section it was a clear, translucent white. The mucosa was not ulcerated. There was a marked angulation brought about by the infiltrating tumor growth. In the angle formed by the bowel were several enlarged lymph-nodes. Some of these were firm and white, others soft and spongy. *Cranial Vault:* Examination of the brain showed moderate œdema with flattening of the convolutions. There was no evidence of meningitis. The outer surface of the left dura (Fig. 2D), presented many flat, soft, elevated areas. These were granular in appearance, and seemed to be loosely attached. There was an area of hæmorrhage three by four centimetres in diameter beneath the endosteum of the left parietal bone. Beneath this were numerous areas of erosion in the bone, varying in size from several

RECTAL CARCINOMA IN YOUTH

millimetres to several centimetres in diameter. Over these areas and between the bone and dura were masses of pale, necrotic-looking material. All the bones of the skull were involved in the same manner to a lesser degree. *Skeleton*: A similar process with multiple, necrotic pockets filled by cheesy purulent material involved the ilium, the sacrum and all the lumbar vertebrae. (Fig. 2C.) A few such areas were also found in the sternum and ribs. The first lumbar vertebra was markedly eroded and showed posterior angulation. From the gross examination it was thought that this was a metastatic tumor arising in the rectum with secondary involvement of the skeletal system, lymph-nodes and the dura. It was evident that the child had died from the effects of a hæmorrhage brought about by erosion of the cranial bone.

Microscopical Examination.—*Rectum*: The sections taken from the rectum showed mucous membrane which was essentially normal in most of its extent, but which at one point changed over into a very dense malignant tissue, apparently arising from the epithelium of the mucosa. The cells in the upper layers were rather large, irregular,

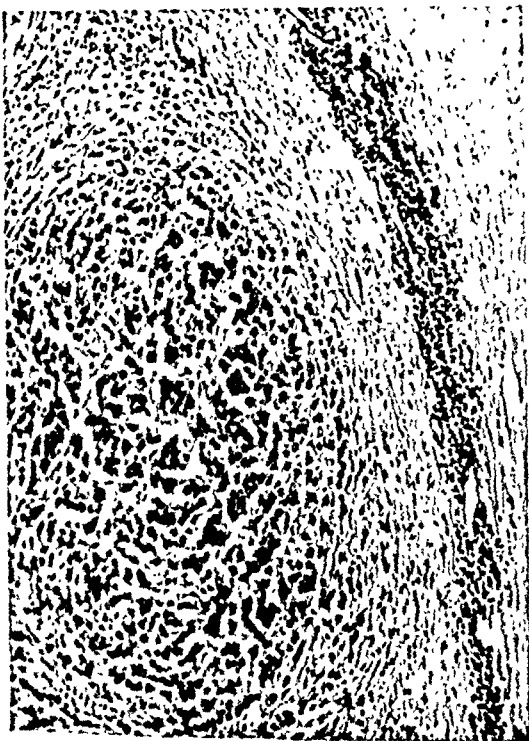


FIG. 5.



FIG. 6.

Fig. 5.—Low-power photomicrograph of a section from one of the mesenteric nodes. This shows a secondary nodule located near the periphery of the gland. The cells are essentially of the same type as those in the original tumor of the rectum but the mucus secretion is less marked.

Fig. 6.—Low-power photomicrograph of a nodule from the dura. This shows a mass of tumor-cells attached to but not invading the dura. They are similar to those of the original tumor but are not actively secreting mucus. In this location the tumor resembles the so-called medullary carcinoma.

and stained deeply. The cytoplasm was moderate in amount and the nuclei were polygonal in shape. From this superficial location, the cells extended downward through a thickened submucosa into the muscularis which was partially destroyed by the invading tumor-cells. (Fig. 3.) Malignant cells could be seen throughout the entire thickness of the rectal wall. In the deeper portions of the tumor, the cells assumed a signet-ring shape typical of those characteristic of mucoid carcinoma. (Fig. 4.) In the isolated nests of cells in the muscular layer there were, in addition to the signet cells, extravasations of mucus, forming small accumulations of a clear, amorphous material. *Glands*: (Fig. 5.) The same type of tumor-cells had entirely displaced the normal structure of the gland. They were large and irregular with a fair amount of granular cytoplasm and irregular polygonal nuclei. Occasional signet-ring cells could be seen, but there was not the marked extravasation of mucus characterizing the primary bowel tumor. *Dura*: (Fig. 6.) The section taken through one of the small white plaques of the dura

showed essentially a normal structure on the surface of which had been deposited a mass of malignant tissue. These cells were identical with those in the sections from the rectum and glands were apparently adherent and growing into the dura. They had not perforated it, however, and did not involve the brain. *Bone*: A section through one of the typical areas in the bone showed a poorly outlined mass of necrotic material in which were nests of tumor-cells and bits of necrotic bone. The tumor-cells were of the type described in the other lesions. In parts of the sections one could also distinguish active invasion of the bone by tumor-cells.

Diagnosis.—*Primary mucoid carcinoma of the rectum*, metastasizing to mesenteric glands, the dura and the skeletal system.

DISCUSSION.—The feature of greatest interest in this case is the appearance of such a malignant tumor in a person of early youth. Malignancy of the bowel occurs with the greatest frequency in patients between forty and sixty years of age. As previously stated, they are not unheard of in the first two decades of life. However, most of the malignant tumors occurring at that age are sarcomas, most frequently of the lymphosarcoma type. That carcinoma arising from the epithelium of the bowel wall should have arisen and metastasized so widely at the age of thirteen years necessitates origination and development at an even earlier age. Such a case as this is of extreme rarity, and it is believed individual in its occurrence. It was remarkable that no symptoms of bowel obstruction were present other than moderate constipation. This is explained by the fact that the tumor had infiltrated the wall rather than producing an ulceration inside the lumen. Although the rectum was converted into a rigid tube, there was no marked obstruction. In dealing with a tumor of this type, one must remember that it is an atypical growth and does not necessarily conform to the mode of extension commonly found in older patients, namely, the ulcerating carcinoma which encircles the bowel and produces an annular constriction. Furthermore, tumors occurring in young people are generally recognized to be more malignant and grow with much greater rapidity than those in older patients.

One may think it amiss that the presence of a bowel lesion was not suspected. However, the diagnosis of tuberculosis of the spine so well fitted the picture that the rectal symptoms of moderate constipation were justifiably given no significance. No doubt, had a gastro-intestinal series been made or a barium enema given, the condition would have been recognized.

The widespread metastases indicate a tumor of unusual malignancy. The secondary growths, however, were located in the skeletal system, a feature which is unusual among gastro-intestinal tumors. The majority of neoplasms in the intestine metastasize first to the mesenteric and retroperitoneal lymph-nodes and then to the liver. In this instance the liver had apparently escaped invasion entirely as the tumor showed a predilection for the skeletal system. The deposits of tumor on the dura can unquestionably be explained as implantations from the opposing skeletal metastasis. Death was due to increase of intra-cranial pressure, caused by hæmorrhage pressing on the cerebral hemisphere.

The onset of the symptoms was coincident with an injury and by some

may be considered related to the trauma. However, as is frequently the case with tumors of bone, this means simply that the injury was the factor calling attention to a pathological process which had no doubt been in existence for several months. There is no treatment which could have possibly been instituted to better the prognosis. The multiplicity of the skeletal lesions contraindicated the use of irradiation. Had the condition been recognized antemortem, section of the sensory fibers of the cord above the lesion might have given the patient temporary relief.*

BIBLIOGRAPHY

¹ Clar: Quoted by Nothnagel.

² Cripps, Harrison: *Diseases of the Rectum and Anus*. The Macmillan Co., New York, 1914.

³ Cullingworth: *British Med. Jour.*, vol. ii, p. 253, 1877.

⁴ Duncan: Quoted by Nothnagel.

⁵ Garrard, W. A.: *Quarterly Med. Jour.*, April, 1897.

⁶ Kanthack, and Furnival, P.: *Trans. Path. Soc.*, vol. xlviii, p. 99.

⁷ Marble, Alexander: *Bull. Johns Hopkins Hosp.*, vol. xlviii, pp. 39-47, January, 1931.

⁸ Nothnagel: *Diseases of the Intestines and Peritoneum*. W. B. Saunders and Co., Philadelphia, 1904.

⁹ Osler, W., and McCrae, T.: *Cancer of the Stomach*. P. Blakiston's Son and Co., Philadelphia, 1900.

* The author expresses his thanks to Dr. A. B. Soule, Jr., for furnishing the pathological material of this case.

ECTOPIC CHORIONEPITHELIOMA

REPORT OF CASE IN WHICH THE LESION WAS SITUATED
IN THE JEJUNUM

BY JOHN B. SEARS, M.D.

OF BOSTON, MASS.

FROM THE SURGICAL SERVICE OF THE BETH ISRAEL HOSPITAL, BOSTON

THIS report and discussion has been stimulated by the occurrence of a very rare lesion (ectopic chorionepithelioma) in a portion of the digestive tract (jejunum) which is but rarely the site of a new growth.

The designation "chorionepithelioma" was first used in 1895 by Marchand,¹² who clearly showed the relationship of the tumor-cells to chorionic elements. The tumors which he described all developed in the uterus and gave rise to varied metastases. In 1902, Zagorjanski-Kissel²⁵ reported eight chorionepitheliomas appearing primarily in the vaginal wall and one case in which the neoplasm was found in the brain and lungs without a primary tumor of the genitalia. In 1905, Dunger⁶ referred to such cases as "ectopic chorionepitheliomas."

Etiology.—Zagorjanski-Kissel²⁵ and several subsequent authors present the view that there are certain chorionepitheliomata which do not arise at the site of placental attachment but rather in distant foci, probably originating from chorionic cells or villi which have penetrated maternal vessels and have been more or less diffusely deposited.

The trophoblast is a normally invasive tissue. Chorionic cells possess the property of digesting the maternal tissues. It is believed that embedding of the ovum is accomplished in this way. They are also endowed with a marked capacity for growth, and, while bathed in maternal blood, they may be broken off and carried by the maternal circulation. The uterine musculature is commonly invaded to a considerable depth by chorionic wandering cells. Masses of trophoblastic tissue and even clumps of chorionic villi may be found in the veins of the uterine wall; or they may be deported to distant fields, more particularly the lungs. Such trophoblastic pulmonary emboli occur in 80 per cent. of women during normal pregnancy according to Schmorl's²⁰ well-known studies. Here, then, we find invasion and metastasis or embolism by a parasitic tissue to be physiological. So similar in constitution and function are chorionic epithelium and malignant tissue of somatic origin that Blair Bell² has hypothecated that chorionic epithelium, particularly the syncytium, is originally malignant in nature, though after a few weeks it comes normally under the control of the developing foetus, that is, its growth is normally arrested at a stage when its functions must subserve the dependent developing embryo. The growth of the chorionic elements is restrained and kept within physiological limits, those in the uterus being ex-

pelled with the placenta at birth and those that happen to be carried by the maternal circulation to the lungs, absorbed.

By checking the advance and further development of dispersed cellular elements the organism of the pregnant woman preserves its integrity from destruction in the same way that it protects itself from bacterial or parasitic invasion. Oscar Fränkl⁸ showed that the serum of a normal pregnant woman is lytic to chorionic epithelium while serum from a patient with chorionepithelioma lacks this lytic power. It is possible, therefore, that the "physiological metastases" of chorionic cells in normal pregnant women are destroyed by this lytic principle. If this capacity is absent, the possibility for the development of a tumor is given. The tumor may develop primarily in the uterus or may develop primarily in organs distant from the uterus (primarily ectopic chorionepithelioma).

Schmorl examined the lungs of 158 patients dying at different stages of pregnancy or after delivery. In 80 per cent. of the normal pregnancies, as mentioned above, he found chorionic cells in the lung capillaries; in 100 per cent. of the eclamptics the lung capillaries contained chorionic elements, sometimes causing extensive obstruction. In two cases of hydatidiform mole and in one of partial mole he noted large numbers of chorionic cells in the lung capillaries and found evidences of proliferation. On the other hand, during the early period of pregnancy he found chorionic elements in the lungs relatively infrequently. Schmorl,²¹ therefore, believed that "ectopic chorionepithelioma" might originate from a previous mole or chorionepitheliomatous proliferation of a placenta completely expelled by labor; *i.e.*, from cells altered *before* leaving the uterus; the alteration, he believed, could be confined to a small area of the placenta. Marchand¹¹ and Pick,¹⁶ on the other hand, maintain that chorionic cells or villi deposited during normal pregnancy may likewise give rise to chorionepithelioma, and that most cases of ectopic chorionepithelioma reveal a history of normal pregnancy, a mole being relatively rare. Walthard²⁴ reports a case of a primary ectopic chorionepithelioma of the vagina developing along with normal pregnancy. A caesarean section and total hysterectomy were performed and no evidences of either tumor or mole were found in the uterus. This case was used to support the opinions of Marchand and Pick, but the interpretations may be questioned because of the known long latent periods which sometimes occur with these tumors. Koritschoner,¹⁰ for example, reports an ectopic chorionepithelioma twenty-two years after the last delivery; but such an extended period may be accepted with due reserve, as the occurrence of an early, overlooked abortion during this long period has to be taken into consideration.

Chorionepithelioma may occur where there is no history or possibility of pregnancy. Teacher²³ believes, with considerable plausibility, that chorionepitheliomata found apart from pregnancy are teratomas "arising from some structure which has the morphologic value of an included ovum and that the chorionepitheliomatous elements represent the actual trophoblast of the in-

cluded ovum." Such lesions have been found most often in the ovary, testis, liver and mediastinum.

In 1927, Bostroem³ introduced a new and very hypothetical interpretation of the origin and development of chorionepithelioma. He states that the tumor arises, not from chorionic cells, but rather from undifferentiated germ cells ("serotinal wandering cells"), which, irritated by humoral influences, react by proliferation, forming primary tumor-cells. The latter, by a process of amitotic division, become syncytial cells which, in turn, by further differentiation give rise to Langhans cells. According to Bostroem's theory, "metastases" are not products of a primary tumor but are the result of an irritative action on undifferentiated germ cells in other organs, similar to that causing the primary tumor. In this sense "metastases" are "sister tumors." de Zalka,⁵ in a comprehensive discussion of this subject, feels that the possibility of a humoral exciting agent may well exist.

CASE—The patient was a thirty-two-year-old Italian housewife referred to the Surgical Service by Dr. S. Gargill, on November 4, 1930, with the complaint of increasing weakness of three months' duration and tarry stools of six days' duration.

She had been well until three months before admission when she noted increasing weakness with the gradual appearance of palpitation, dyspnoea and marked weakness on exertion. There was no precordial pain or oedema. For three weeks before entry she had a "feeling of soreness" in the epigastrium, unrelated to meals and unrelieved by food; for six days before entry she suffered nausea and vomiting about thirty minutes after taking a greenish medicine, and her stools had become black. There was no hematemesis, abdominal cramps, diarrhoea or constipation. Despite treatment she became worse and was forced to bed five days before entry. For six days there were yellow spots before her eyes with blurring, and for three days she had double vision and tinnitus.

Her family history was irrelevant. She had three children, all healthy, and her last pregnancy, according to her story, ended in a miscarriage after two months in December, 1927. She attributed this mishap to overwork. (On further investigation after her death, we learned that this patient entered the Middlesex Hospital, Cambridge, on December 25, 1927, complaining of uterine hæmorrhage. Her last period occurred on October 3, 1927. She missed her November 3 period but began to flow November 20, since which time she had been flowing steadily and profusely. On the night of her admission she expelled a large number of "black clots without membrane." After the sixth day the bleeding subsided and she was discharged, without operation, January 7, 1928. No microscopical examination was made. Two weeks after she left the Middlesex Hospital, she began to bleed again; her family doctor curetted her at home and reports that he found nothing unusual.)

Physical examination showed a restless, anxious, pale woman of good development and nourishment. Her mucous membranes were pale. Heart was normal in size with sounds of good quality. Rate, 120; regular rhythm with a rough blowing systolic murmur heard all over the precordium, best over the mitral area; diastolic blow over the mitral area. P 2 greater than A 2. Blood-pressure: systolic, 100, diastolic, 50. Lungs were clear throughout. The abdomen was negative save for slight epigastric tenderness. Pelvic examination showed moderate cystocele and rectocele; cervix slightly lacerated and cystic; fundus normal in size, in retroposition; vaults clear. Examination of the extremities showed a few bilateral varicose veins. Temperature was 100.6° (rectal); respirations 28.

ECTOPIC CHORIONEPITHELIOMA

Clinical Pathology.—Urine essentially negative. Red blood count, 1,620,000; hæmoglobin, 30 per cent. (T.); white blood count, 12,900; differential count showed 90 per cent. polymorphonuclears, 9 per cent. lymphocytes, 1 per cent. large mononuclears. No anisocytosis, occasional tail forms, moderate achromia, platelets normal. Stools were black, formed, and showed a strongly positive benzidine reaction for occult blood. Blood culture, negative. Hinton, Kahn and Wassermann reactions negative.

Clinical Progress.—On admission diagnosis was made of: secondary anæmia, ? rheumatic heart disease, ? subacute bacterial endocarditis and ? gastro-intestinal bleeding. The patient was placed on a first-stage Sippy régime without powders; was given glucose and saline by rectum; also morphine. She was given two transfusions of 500 cubic centimetres each on the second and fourth days after entry; there was only slight improvement. Six days after entry (November 10) she developed phlebitis of the right thigh. November 16 occult blood still present in stools; no improvement in blood picture. Treatment changed to water by mouth and rectal glucose. November 18 third transfusion. November 19 red blood count 1,740,000. Gastro-intestinal X-rays showed "a slight irregularity of the lesser curvature at the prepylorus and a constant incisura opposite this irregularity in the greater curvature with asymmetry of peristaltic waves in this region. These findings point to a lesion in this region." November 22 fourth transfusion and exploratory laparotomy. Dr. H. K. Sowles, spinal anæsthesia. "Median epigastric incision made. There was a mass as large as a small orange in the edge of the left lobe of the liver. On the under surface of the liver this mass had ruptured through the capsule, and the omentum was adherent to the liver at this point. Duodenum, pylorus and stomach seemed perfectly normal. No signs of any bleeding. Wound in the duodenum was closed. Mass on the edge of liver felt fluctuant; it was explored with a needle and nothing found. It was also explored by blunt dissection with finger tip from the under side. It seems to consist of a soft, dark, blood-stained tissue nearly black in color. Very little bleeding. Piece of liver removed for pathological examination. Because of the patient's general condition, the rest of the abdomen was not explored. Wound closed without drainage." Pathological report of biopsy S-30-1074: "Hematoma of liver and omentum."



FIG. 1.—The gross specimen showing the hæmorrhagic, necrotic, crater-like ulceration in the jejunum.

November 24 evidence of bronchopneumonia. December 2 acute phlebitis in right leg and thigh with swelling. Bronchopneumonia disappeared but patient continued to go down hill. Stools continued to contain occult blood and red blood-cells kept dropping (1,500,000).

December 5 resection of tumor of small intestine, end-to-end anastomosis, fifth transfusion by Dr. Charles G. Mixter under spinal anæsthesia. When the abdominal cavity was opened a mass about the size of an orange, the color of an eggplant, was seen protruding from the left lobe of the liver and adherent to omentum. Ligament of Treitz was exposed and small bowel was followed down from this point for four to five feet when a lemon-sized mass originating in the intestine and tending to perforate the adherent omentum was found. There were several bean-sized glands in the

mesentery of the small intestine in this region. About fourteen centimetres of intestine were resected; end-to-end suture. Because the specimen seemed to be malignant, further investigation of the liver tumor was deemed inadvisable. Patient transfused.

December 7 operation was followed by paralytic ileus which was relieved by inlying Levin's tube. Wound sepsis (minor).

December 14 phlebitis right leg flared up again. Ascheim-Zondek test strongly positive. X-rays of long bones and chest negative for metastases. Intensive X-ray treatment begun. Stools negative for blood.

December 22 despite deep therapy to abdomen and liver (six treatments, each of 200 "r" units), the mass in the liver seems to be increasing in size, down to the umbilicus. Increasing weakness and restlessness; loss of appetite. January 5, 1931, died. Pathological examination and report by Dr. Monroe Schlesinger.—Specimen consists of a strip of the wall of the small intestine. It presents a large bulging hæmorrhagic mass on its external surface. (Fig. 1.) The strip of gut measures 13.5 centimetres long, and has a circumference of 5.5 centimetres. In the middle of this portion of tissue the bulging mass from the external surface is seen. It measures five centimetres

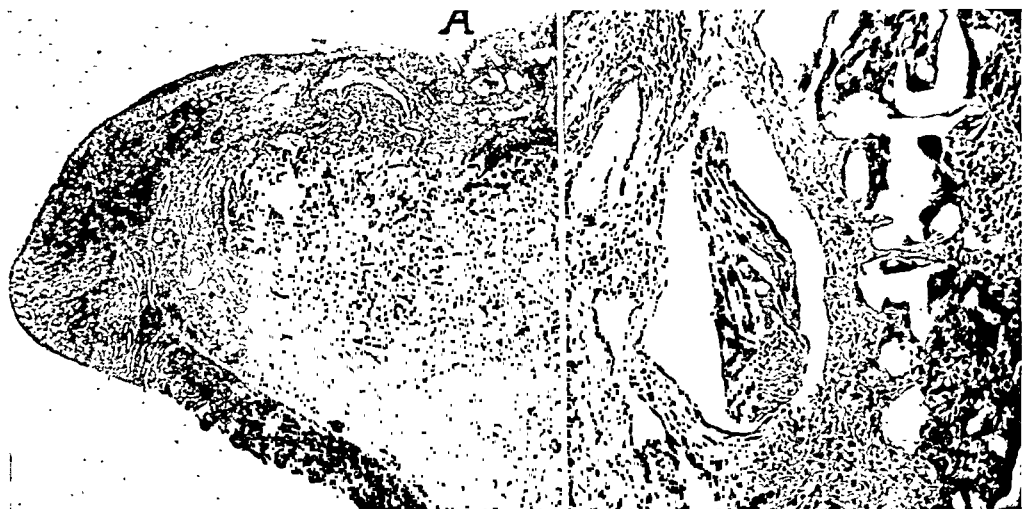


FIG. 2.

FIG. 3.

FIG. 2.—Low-power view showing invasion of mucosal surface of gut. The coagulum of red blood-cells and fibrin may be seen at A.

FIG. 3.—High-powered detail from Fig. 2, showing invasion of lumen of blood channel by tumor-cells.

by three centimetres. There is a considerable amount of yellow, fatty and fibrous omental tissue wrapped around it. When this is lifted up the mass is seen to be hæmorrhagic and necrotic. There is a clear wavy line of demarkation between the hæmorrhagic tissue and the adjacent tissue, which, however, is grayish in color, and beyond this gray zone it gradually merges into the normal-appearing pinkish coat of the intestine. It feels soft and doughy throughout. Looking at this area from the inside one sees a large crater-like ulceration about five centimetres across and 3.5 centimetres long. The longer measurement is parallel with the transverse diameter of the gut. This ulcer is hæmorrhagic and necrotic and has rolled-up edges of 0.3 centimetres in thickness. The ulcer presents elevated areas of necrotic hæmorrhagic tissue with intervening furrows and ridges. It shows a coloration of black, yellow and red areas. The base of this ulcer presents a convexity facing the lumen of the gut. These firmer elevated masses of tissue can be felt in contrast to the softer and thinner tissue. The cut surface shows grayish, hæmorrhagic, and black areas. The base shows a thickness of 0.2 to 0.5 centimetres and the edges are 0.5 centimetres thick.

Microscopical sections from the border and base of the ulcer show an abrupt cessa-

tion of the normal mucosa with glands, lymphoid tissue, *etc.*, at the border of the ulcer. Then, there is a zone of granulation and inflammatory tissue heavily infiltrated with polymorphonuclears and round cells. (Figs. 2 and 3.) Nearer the base of the ulcer the tissue is entirely necrotic and hæmorrhagic and in some places heavily infected with bacteria. This necrosis extends almost through the wall. Near the serosal surface the tissue is better preserved and here it is infiltrated with tumor. This tumor infiltration extends as a zone completely about the necrotic area and is found well out in the various layers of that part of the intestine covered by fairly well preserved mucosa. The tumor consists of an irregular jumble of various kinds of cells all epithelial in nature. These cells can be placed in two groups, one having abundant, pale pink, somewhat foamy cytoplasm, and a large, irregular-shaped vesicular nucleus often with a nucleolus. Many of these cells form multinuclear giant tumor-cells. Many have very large loose nuclei. Mitoses are numerous in these cells. Closely intermingled with this type of cell are small strands and masses of cells having smaller, more uniform and more compact nuclei. Their cytoplasm is usually somewhat more purplish than the other tumor-cells and these cells are usually multinuclear. These two types of



FIG. 4.

FIG. 4—Study showing the deeply stained syncytial cells and the lighter Langhan's cells; also debris, red cells and fibrin.



FIG. 5.

FIG. 5—High-powered study of both types of cells; many mitotic figures are present.

cells represent the Langhan's layer and the syncytial layer. However, they are here inextricably mixed up and both are growing into the normal structures in an apparently unopposed, very active fashion. They can be seen growing through the walls of blood-vessels and also completely filling a blood-vessel. Areas of marked hæmorrhage are found throughout. In the few larger areas of tumor which are not necrotic there is a very scanty stroma consisting mainly of small capillaries. *Diagnosis.*—Ectopic chorionepithelioma of jejunum.

Further sections were made of the original biopsy specimen from the liver and careful study showed that "in spite of the generalized necrosis there are recognizable a few small groups of cells which closely resemble the chorionepitheliomatous cells found so abundantly in specimen 30-1074."

Post-mortem examination was limited, unfortunately, to the uterus, tubes and ovaries. The uterus and tubes showed evidence of chronic endometritis, chronic cervicitis and chronic salpingitis. The findings in the ovaries are worth a detailed report.

Specimen 30-1074A.—“The ovaries are oval in shape and yellow in color. They measure 3 by 1.5 by 0.5 centimetres, and are firm to palpation. About the hilus of one ovary there are several purplish cystic dilatations which, on section, appear to be thrombosed veins. Springing from the surface of the other ovary there is a red bulging hæmorrhagic body which feels rather solid and is one centimetre in diameter. On section the ovary is firm and presents a smooth, solid, yellowish-gray surface. The hæmorrhagic body has a moderately firm whitish-yellow area in its centre.”

Microscopical examination of the latter ovary showed (Figs. 4 and 5) in addition to ovarian stroma and corpora lutea, “a proliferation of chorionic syncytial and Langhan’s cells. These occur in large hæmorrhagic areas. There are large multinuclear giant cells of the syncytial type, lying side by side with the large nucleated pale cells of the Langhan’s type. Frequent mitotic figures are seen. Loops and knots suggestive of villi are seen.” Sections of the other ovary showed no tumor.

DISCUSSION.—What conclusions may one draw as to the etiology of the lesions in our case? There are these possibilities:

(1) *The lesion may have originated as part of a teratoma of the ovary or the liver and then metastasized to the jejunum.* This we consider least likely. After puberty, ectopic chorionepithelioma should be considered teratomatous in origin only where such parts can be demonstrated or where pregnancy can be absolutely excluded. Previous to puberty, de Zalka feels that all cases should be regarded as teratogenous.

(2) *The lesion may have originated in connection with an ovarian pregnancy.* There is no evidence for such an assumption in our case.

(3) *The ectopic lesions arose from malignant degeneration of trophoblastic emboli.* The chorionic elements may have been deposited in the left ovary, liver and jejunum, without there having been a primary uterine tumor; these deposits may have degenerated into multiple tumors or into one tumor with metastasis to the other organs. If the latter is the mechanism we believe the jejunal tumor to be primary because it was the largest and most active of the three growths; it could have reached the ovary in a retrograde manner as does the Krukenberg tumor of the ovary which is secondary to a lesion in the upper gastro-intestinal tract.

(4) *A uterine chorionepithelioma was the primary lesion and, although the metastases ultimately killed the patient, the primary lesion disappeared either by spontaneous healing or by expulsion or by curettage.* Novak and Koff^{14, 15} state that complete recoveries have occurred not only after incomplete operations but even spontaneously. This possibility seems the likely one. The “black clots without membrane” passed in 1927 may perfectly well have been a chorionepithelioma.

Literature.—The relative infrequency of malignant tumors of the jejunum and the difficulties encountered in their diagnosis has been sufficiently stressed in such recent papers as those by Rankin and Mayo,¹⁸ Raiford,¹⁷ and Johnson.⁹ The latter author reported from Vienna 41,838 necropsies in which 3,585 carcinomata were revealed; 343 of these were intestinal, of which ten were in the ileum and none in the jejunum. Raiford reports from the Johns Hopkins Hospital a series of eighty-two tumors located between the pylorus

and the ileocecal junction and constituting 6.5 per cent. of all of their gastrointestinal tumors. In his series, eighteen were in the duodenum, fourteen in the jejunum (seven were benign) and forty-three in the ileum; in seven the location was not determined. Forty-six per cent. of his cases were asymptomatic.

The literature on ectopic chorionepithelioma has been scanty, particularly during the past twenty-five years, indicating that its occurrence is rarer by far than its extremely rare uterine prototype. In 1904, Findlay⁷ collected twenty cases reported during the previous seven years, chiefly in the German literature, and reported a new case. The vagina was believed to be the primary seat in eleven cases, the uterine muculature in three, the cervix, brain, kidney and labium each in one case; in the remaining three it was not possible to identify the primary growth. Further cases have been reported from time to time, but little has been added to our knowledge of the lesion, even when it occurs primarily in the uterus. de Zalka, in a comprehensive review published in 1928, has collected twenty-six cases primarily in the ovary and five cases primarily in the liver.

Our survey of the literature revealed almost no cases which resemble clinically the presentation in this paper. No report of a similar lesion in the jejunum was found. Nolasco,¹³ in 1927, reported the case of a female Filipino, aged twenty, who had aborted a three months' foetus five months before entry. She complained of fever, abdominal pain and vomiting. Two weeks before entry she passed fresh bloody stools. A clinical diagnosis of typhoid fever with intestinal hæmorrhage was made. At autopsy, six days after entry to the hospital, in addition to chorionepitheliomatous lesions in the lungs, left kidney and liver, an area of ileum, eight centimetres long and ninety centimetres below the duodenum, was found to contain three masses of chorionepithelioma. The genitalia showed no evidence of chlorionepithelioma.

Novak quotes a case in which a woman six months after an operation for ruptured tubal pregnancy showed the picture of severe intra-abdominal hæmorrhage. At operation twelve inches of ileum were resected because of profuse bleeding from intestinal implants of chorionepithelioma. There were also hæmorrhagic implants on the bladder and omentum. No mention is made as to the depth of invasion of the intestinal wall; nor is hæmorrhage into the lumen of the bowel noted.

Lutein Cysts.—A consideration of this subject would be incomplete without brief reference to a frequent accompaniment of both chorionepithelioma and its benign prototype; we refer to the multiple lutein cystic changes first described by Marchand. (Such changes were not observed by us.) Coventry⁴ states that these cysts are found with 91 per cent. of chorionepitheliomata and with over 80 per cent. of moles. A much lower incidence is given by the several authors quoted by Novak and Koff, who stress the inaccuracy of the statistics. The majority of investigators hold to the view that the ovarian

changes represent a characteristic response to the exaggerated trophoblastic stimulus associated with choriomatous tumors.

In the light of the newer knowledge following the epoch-making studies of Zondek and Ascheim, and Smith and Engle,²² this hyperluteinization must be attributed to anterior pituitary principles which are associated with activity of trophoblastic tissue. This relationship is ably discussed by Novak and Koff.

Notes on Diagnosis and Treatment.—The ectopic variety of chorionepithelioma occurs with such extraordinary infrequency that its diagnosis, clinically, can rarely be suspected unless there is some suggestive antecedent history or unless the use of the Ascheim-Zondek¹ test or one of its modifications eventually becomes a routine procedure in cases of tumor or unexplained bleeding, regardless of the system involved. It is obvious that, with a new growth that invades and erodes blood-vessels with such rapidity, bleeding from the lungs, gastro-intestinal or genito-urinary tracts will occur relatively early in the active stage of the disease.

Since these tumor-cells are of an embryonic, anaplastic and undifferentiated character, it would be reasonable to expect chorionepitheliomata to be highly radio-sensitive. Schmitz and Hueper¹⁹ report success in two cases of *uterine* chorionepithelioma treated by X-ray therapy alone; also four cases treated successfully by combined treatment (surgery plus X-ray treatment). These authors advocate combined therapy, admitting that the number of cases successfully treated by irradiation is too small to warrant any positive conclusions. Our patient reacted so severely to deep therapy that we were unable to give optimum dosage; what dosage she did receive apparently had not the slightest therapeutic effect.

In general, the treatment in cases of *ectopic* chorionepithelioma has had little influence on a mortality of practically 100 per cent. From the aforementioned work of Fränkl and from the newer knowledge of the interrelationships of the ovarian, placental and pituitary hormones, there is a faint suggestion that the treatment may some day be non-surgical, *i.e.*, it may consist of the use of anterior pituitary or other endocrines, alone or in combination, and transfusions of blood from pregnant women.

Once the diagnosis of ectopic chorionepithelioma is made, the treatment, in the light of our present knowledge, should be radical surgery when possible, supplemented by high voltage radiation. Even if metastases are present, radical surgery, when possible, is indicated because regression of metastases has been observed in such cases.

SUMMARY AND CONCLUSIONS

(1) A case of ectopic chorionepithelioma with lesions in the jejunum, liver and ovary is reported. The etiology of the lesions in this case is discussed.

(2) The literature dealing with the etiology of ectopic chorionepithelioma in general is summarized.

ECTOPIC CHORIONEPITHELIOMA

(3) The diagnosis of chorionepithelioma, uterine or ectopic, merits consideration in every case of unexplained bleeding in a woman.

(4) The combined use of radical surgery and high-voltage radiation is advocated.

(5) The use of the Ascheim-Zondek test in diagnosis and prognosis, and the use of radiation in treatment comprise most of what is recent advance in our knowledge of the subject.

(6) The experimental use of endocrine therapy and transfusions of blood from pregnant women is suggested.

BIBLIOGRAPHY

¹ Ascheim: *Am. Jour. Obs. and Gynec.*, vol. xix, p. 335, 1930.

² Bell: *Jour. Obs. and Gynec. of Brit. Emp.*, vol. xxxv, p. 233, 1928.

³ Bostroem: *Beitr. z. path. Anat. u. z. allg. Pathol.*, vol. lxxvi, p. 293, 1927.

⁴ Coventry: *Trans. Am. Gynec. Soc.*, p. 399, 1920.

⁵ de Zalka: *Am. Jour. Path.*, vol. iv, p. 59, 1928.

⁶ Dunger: *Beitr. z. Path. Anat. u. z. allg. Path.*, vol. xxxvii, p. 279, 1905.

⁷ Findlay: *Jour. Am. Med. Assn.*, vol. xliii, p. 1351, 1904.

⁸ Fränkl, quoted by Schmitz and Hueper.

⁹ Johnson: *Brit. Jour. of Surg.*, vol. ix, p. 422, 1921.

¹⁰ Koritschoner: *Centralbl. f. allg. Path. u. path. Anat.*, vol. xxiv, p. 967, 1913.

¹¹ Marchand: *Ztschr. f. geburtsch. u. Gynak.*, vol. xxxix, p. 173, 1898.

¹² Marchand: *Monatschr. f. Geburtsch. u. Gynak.*, vol. i, p. 419, 1895.

¹³ Nolasco: *Jour. Med. Assn. Philipp. Islands*, vol. vii, p. 323, 1927.

¹⁴ Novak, and Koff: *Amer. Jour. Obs. and Gynec.*, vol. xx, p. 153, 1930.

¹⁵ Novak, and Koff: *Amer. Jour. Obs. and Gynec.*, vol. xx, p. 481, 1930.

¹⁶ Pick: *Berl. klin. Wchschr.*, vol. xli, p. 158, 1904.

¹⁷ Raiford: *Radiology*, vol. xvi, p. 253, 1931.

¹⁸ Rankin, and Mayo: *Surg. Gynec. and Obst.*, vol. 1, p. 939, 1930.

¹⁹ Schmitz, and Hueper: *Jour. Am. Med. Assn.*, vol. xcv, p. 1413, 1930.

²⁰ Schmorl: *Centralbl. f. Gynak.*, vol. v, p. 129, 1905.

²¹ Schmorl: *Verhandl. d. Deutsch. path. Gesellsch.*, vol. viii, p. 39, 1904.

²² Smith, and Engle: *Am. Jour. Anat.*, vol. xl, p. 159, 1927.

²³ Teacher: *Jour. Obs. and Gynec. of Brit. Emp.*, vol. iv, p. 1, 1903.

²⁴ Walther: *Ztschr. f. Geburtsch. u. Gynak.*, vol. lix, p. 443, 1907.

²⁵ Zagorjanski-Kissel: *Arch. f. Gynak.*, vol. lxxvii, p. 326, 1902.

²⁶ Zondek, and Ascheim: *Arch. f. Gynak.*, vol. cxxx, p. 1, 1927.

TRANSACTIONS

OF THE

NEW YORK SURGICAL SOCIETY

STATED MEETING HELD NOVEMBER 23, 1932

The President, DR. JOHN DOUGLAS, in the Chair

SUPPURATIVE CHONDRITIS OF COSTAL CARTILAGES

DR. JOHN H. MORRIS presented a man who at fifty years of age contracted a virulent Type I bronchopneumonia in February, 1931. Bases of both lungs were involved and treatment included appropriate serum therapy. After a stormy four weeks' course symptoms abated somewhat, but continued low-grade temperature, together with persistent signs of solidification below the angle of the right scapula, led to X-ray investigation. Left lung presented unresolved areas of pneumonitis in middle lobe and hilus while in the right there was suggestion of encapsulated fluid in region of the oblique fissure between upper and middle lobes. Thoracentesis yielded only a small quantity of thin serosanguinous fluid. There was little change in this picture up to May, when he developed an abscess of left deltoid muscle from which a pure pneumococcus culture was obtained. Late in May acute symptoms had completely subsided but upon discharge from the hospital the patient complained of pain and tenderness over the costal margin just to the left of the sternum. Early in June he consulted a surgeon, while in another city, because of tender swelling in the region of this pain. Immediate operation carried out at this time was described as "incision of abscess and scraping of rib." He came under Doctor Morris's observation again six weeks later at which time there was a well-organized fistula at site of healed operative wound. Operation was again advised and on this occasion the fistula was widely excised and its source explored. A circumscribed area of osteomyelitis was found at the sternal end of the sixth rib just beyond chondro-costal junction. It was confined to osseous tissue; the cartilage itself was perfectly healthy. Four inches of sternal end of osseous rib were removed with periosteum, and corresponding cartilage with a small piece of sternum was included. The character of the cavity seemed to permit primary closure and wound was closed save for small rubber tissue drain at outer angle. The wound healed rapidly but, when about completely closed, recurrence of old sinus was evident. In October, 1931, operation was again undertaken; old scar and fistula widely excised down to pleura at site of former excision. Fifth costal cartilage was also exposed and, although appearing grossly healthy, was removed. All necrotic material, including bone, laid down since previous operation were carefully removed to leave a clean cavity. The wound was then packed wide open and permitted to close by secondary granulation. By January, 1932, the area had completely closed in but the original sinus had again reformed.

At this time another culture from the sinus disclosed pneumococcus Type I. A guinea-pig injected at this time with wound material was subsequently reported normal and free from evidence of tuberculosis.

POST-OPERATIVE FISTULA OF LARGE GUT

DR. ALEXIS V. MOSCHCOWITZ stated that when he read a paper upon this subject in 1918 before the American Surgical Association, he reported several cases of suppurative chondritis caused by various organisms. In that paper, he volunteered the statement that on account of certain inherent anatomical qualities of the cartilage, principally lack of blood-vessels, suppurative diseases of the cartilage do not heal well. He therefore advised that the entire involved cartilage be extirpated so that at the termination of the operation no cartilage shall be visible in the wound.

He now wished to modify the statement inasmuch as one case of suppurative chondritis had healed without any radical operation. As a general rule, however, the dictum still holds good that it is best to extirpate the entire involved cartilage and he is of the opinion that eventually this will have to be done in the case presented by Doctor Morris.

DR. FRANK B. BERRY said that he had seen a number of cases of tuberculous chondritis on the Tuberculosis Service at Bellevue Hospital and he agreed with Doctor Moschcowitz that in order to effect a cure it is necessary to do a radical operation. In most cases it seems likely the disease starts in one of the lymph-glands of the anterior mediastinum. There are cases, however, in which radical operation cannot be done. He saw such a case today. The patient has osteomyelitis coming through the middle of the sternum and in order to remove the cartilage, it would also be necessary to remove a large segment of the entire sternum, which seems hardly justifiable. That is the only case of its kind that the speaker has seen. Most of them come through one of the margins and one can close such a case by radical operation.

DR. JOHN DOUGLAS said he could add a case to those which led Doctor Moschcowitz to retract his previous statement. It was that of a patient shown before this society seven or more years ago in whom the common bile-duct had been repaired following a very bad infection. There had been extensive destruction of the costal cartilages from the original infection. After awhile the wound healed up without a secondary operation to remove the cartilages, only some curettage being done.

DOCTOR MORRIS rejoined that in his case it was demonstrated there was no tuberculosis. The man had pneumococcus bacteræmia. It is important to make that distinction here. In Doctor Moschcowitz's series two were tuberculosis and one was actinomycosis. The speaker has received personal communications of cases here in town which have been in New York hospitals in the last few months. Two of these were traumatic, requiring radical excision of the cartilage, and cure had apparently followed this procedure.

POST-OPERATIVE FISTULA OF LARGE GUT. TREATMENT BY IRRADIATED PETROLATUM

DR. MORRIS presented a woman, nineteen years of age, who was admitted to Fourth Surgical Division, Bellevue Hospital, May 13, 1930. December 2, 1929, she suffered a spontaneous miscarriage at the third month, following which she was twice curetted for uterine hæmorrhage. In February,

1930, she developed lower abdominal pain and was operated upon for pelvic tumor which was said to be inoperable and abdomen was closed after simple exploration. Recovery from operation was uncomplicated but before discharge from hospital a sinus had developed in the operative wound and this sinus has discharged foul pus up to time of admission to Bellevue. Previous history was entirely negative as regards illness or operations. She was well-nourished and did not appear acutely ill. Vaginal examination revealed a large, fixed, tender mass on right side of pelvis with normal-sized uterus pushed to left. Mid-line suprapubic abdominal scar presented a well-organized fistula leading deep into pelvis.

May 22, 1930, her abdomen was opened through the old scar, following the fistulous track to a chronic inflammatory mass involving right adnexa and right broad ligament. Mass freed by blunt dissection and removed together with fundus of uterus. *Pathological report.*—Tuberculous salpingitis.

The post-operative course was stormy with temperature elevation, distention and vomiting. On eighth post-operative day the wound, which was badly infected, broke down and required secondary suture under general anæsthesia. Two and one-half months later, after wound had completely granulated in, a fæcal fistula developed at its mid-point. During the ensuing twelve months this fistula resisted the conventional methods of treatment such as cauterization with carbolic, curretting, *etc.*, and it was finally decided in view of the patient's general improvement, to again attempt excision.

As a last resort, however, it was decided to try injections of irradiated petrolatum. This treatment was started September 15, 1931, and six treatments at three-day intervals were given, following which fistula closed and has remained so up to date.

RETROPERITONEAL HERNIA COMPLICATED BY VOLVULUS AND GANGRENE OF CÆCUM AND ASCENDING COLON

DR. MORRIS presented a man, thirty years of age, who was admitted to the Fourth Surgical Division, Bellevue Hospital, May 8, 1924, complaining of acute abdominal pain and vomiting. The immediate attack began shortly after dinner on the evening preceding admission to the hospital when the patient was taken with an acute, severe pain centring about the umbilicus. The pain rapidly became generalized and by 10:30 P.M. he became nauseated and began to vomit. By 4 o'clock next morning these symptoms became so severe that he was brought to the hospital.

His antecedent history was irrelevant save for the fact that during the previous five years he had experienced a great deal of chronic indigestion in the form of anorexia, nausea and epigastric distress after food. On several occasions there had been definite attacks of epigastric pain which came on about one hour after eating and from which he was able to secure relief by taking sodium bicarbonate. He had been severely constipated for several years.

On examination he presented a picture of acute distress with anxious facies and grayish pallor of skin. His pulse was extremely rapid and was of very poor volume and quality. The abdomen was greatly distended, very tender to palpation and presented general board-like rigidity. Free fluid could be detected in the flanks. Rectal temperature, 98.6°; white blood cells, 27,000; polymorphonuclears, 96 per cent. The presumptive diagnosis was perforated duodenal ulcer.

The abdomen was opened through a right-rectus incision evacuating a large amount of blood-stained fluid. On spreading incision a peculiar picture was revealed, the small intestine having apparently disappeared from

the peritoneal cavity. In the left posterior gutter and occupying the entire rectangular space mapped out by the left half of the transverse colon above the descending colon and sigmoid to the left, the pelvic brim below and the lumbar spine mesially there appeared a globular tumor about the size and shape of a football covered by posterior peritoneum over which coursed numerous vessels giving the tumor the appearance of a large ovarian cyst. The stomach and transverse colon were pushed high up under costal margin and the descending colon and sigmoid were displaced well over to the left. The hepatic flexure and adjacent portion of the ascending colon were in their normal relations but at its mid-point the ascending colon turned acutely towards the tumor mass and disappeared therein through an orifice low down in right side. Shining through the glistening membranous covering of the tumor intestinal coils could be made out and in addition thereto a dark hæmorrhagic mass.

Posterior peritoneum incised over the tumor in avascular area and a 26-inch segment of gangrenous ileum and ascending colon delivered into general peritoneal cavity. This segment resected and end-to-end anastomosis established between ileum and colon. After completion, however, a hæmatoma was observed in root of mesentery opposite anastomosis and as an additional safety factor, a rapid side-to-side anastomosis, ileum to ascending colon, was made to short-circuit this area. Intestine was then returned to retroperitoneal space and posterior peritoneum closed. Attempts to reduce hernia were considered unwise because of condition of patient and abdomen was closed without drainage.

The patient made a good recovery and was discharged from the hospital on the twenty-fifth post-operative day. He has been under observation since operation and with exception of epigastric distress, gaseous distention and fullness after meals, has remained perfectly well to date.

DR. BRADLEY L. COLEY said that retroperitoneal hernia is still rarely seen. In 1924, Short was able to collect only thirty-eight cases in the medical literature up to that time. Of these, fifteen were of the left paraduodenal type, similar to the one which had just been shown. In 1928, the speaker had occasion to look up the literature and found an additional seven cases of left paraduodenal hernia, and reported a case of his own.*

Doctor Coley's case was admitted to Bellevue Hospital, Second Surgical Division, October 26, 1926, with a history of attacks of abdominal pain, of cramp-like character, associated with obstipation, and frequently with vomiting, which had persisted over a period of twenty years. Six months prior to his admission he was seized with a particularly severe attack, and at that time X-ray studies were advised, but not made. On admission to Bellevue Hospital he was acutely ill and was operated upon under a diagnosis of acute abdomen, the exact nature of which was uncertain. At operation a large tumor was found, similar to the one described by Doctor Morris and containing about four feet of markedly hypertrophied small intestine, at one point of which a beginning intussusception was found. This is of interest in view of the findings in Doctor Morris's case of volvulus, and in both instances may be explained on the basis of a hyperperistalsis.

* Strangulated Left Duodenal Hernia, Archives of Surgery, March, 1929, vol. xviii, pp. 868-881.

The speaker called attention to the importance of not dividing the neck of the sac, which in left paraduodenal hernias contains the inferior mesenteric vein. He was able by traction and taxis to reduce the contents after blunt dissection had elongated the neck of the sac without damaging the vessels. The marked hypertrophy of the contained intestine was striking and suggested a long-continued effort to keep up peristaltic action in the face of mild and intermittent obstruction.

CARCINOMA OF STOMACH. SUBTOTAL RESECTION

DOCTOR MORRIS presented a man aged fifty-three, a laborer, who was admitted to the Fourth Surgical Division of Bellevue Hospital, June 8, 1931, complaining of digestive symptoms of ten years' duration, which had consisted of "heartburn," epigastric distention, and eructations coming on about three hours after taking food. Two months before admission he began to vomit irregularly after meals. He has never noted any associated pain. During the past year he has lost 10 pounds in weight. He has never vomited blood or noted dark-colored stools. Venereal history negative and there was no history of any previous illness. He was a pallid, cachectic, dehydrated male of fifty-three. Abdomen scaphoid type but no abdominal tumor was palpable. General examination negative except for presence of small, hard, discrete mass in right lobe of thyroid gland. Wassermann negative; red blood cells, 4,670,000; hæmoglobin, 75 per cent. X-ray reported "neoplastic infiltration of pyloric region with 40 per cent. six-hour residue."

Operation under spinal anæsthesia disclosed pyloric mass adherent to pancreas posteriorly and extending well up into body of stomach. Liver was not grossly invaded but several large glands were noted in gastrohepatic omentum. Mass resected widely and a retrocolic anastomosis of polya type carried out without clamps. *Pathological report*.—"Adenocarcinoma of stomach."

He made a good recovery and was discharged from hospital one month after operation symptom-free. At subsequent follow-up clinics, however, he complained of the regurgitation of small amounts of fluid soon after eating. Appetite remained good, there was no pain or indigestion, and he progressed in weight. Regurgitation continued in spite of careful dietary régime. Total gain in weight since operation 20 pounds.

February 8, 1932, X-ray shows normal functioning stoma with no evidence of recurrence. Gastric analysis (fractional) at this time showed no free hydrochloric acid or lactic acid. Total acidity as high as 50. Occult blood positive.

CASE II.—Man, aged forty, was admitted to Fourth Surgical Division of Bellevue Hospital, November 22, 1931.

Up to one month before admission he had enjoyed perfect health and had never experienced any type of gastric disturbance. About this time, however, he began to complain of a dull, burning pain referred to the umbilical region, coming on immediately after the taking of food and always relieved by vomiting. At irregular intervals he suffered from severe vomiting attacks which appeared to be unrelated to food, and on one occasion vomitus was said to have contained blood. Between these attacks there was pronounced epigastric distention and belching of gas. During the past month he had lost progressively in weight (15 pounds) and strength.

In the epigastrium just to right of mid-line there could be felt a hard, irregular, fixed mass about the size of a large orange. The chest presented an area of flatness over base posteriorly and there was systolic murmur over

ACUTE APPENDICITIS WITH TENOUS THROMBOSIS

aortic region of heart. Physical examination otherwise negative. X-ray reported a "persistent deformity of prepyloric region characteristic of neoplastic infiltration."

Operation preceded by whole-blood transfusion was carried out under spinal anaesthesia. Pathology consisted of an annular mass extending from the pyloric vein well into the body of the stomach. No evidence of gross involvement of the liver but there were several enlarged, hard, subpyloric glands. Stomach mobilized, growth widely resected and retrocolic anastomosis of polya type carried out without clamps. *Pathological report.*—Adenocarcinoma of stomach.

Post-operative course uneventful. Temperature and pulse rate normal on third post-operative day. Discharged from hospital on eighteenth post-operative day.

This patient has been entirely symptom-free to date, has enjoyed an excellent appetite and has made a total gain in weight since operation of 35 pounds.

ACUTE APPENDICITIS WITH THROMBOSIS OF MESENTERIC VEINS. EXCISION OF VEINS

DR. PERCY KLINGENSTEIN presented a man, twenty-seven years old, who was admitted to Doctor Lewisohn's service, Mt. Sinai Hospital, with the following history: Twenty-four hours before admission he was seized with epigastric pain, which localized in the right lower quadrant of the abdomen twelve hours after onset, and had been persistent since then. There was associated nausea and vomiting; a temperature of 104° . He volunteered that prior to admission he had had three shaking chills, one lasting about three minutes, during which his teeth chattered. The other points in the history were irrelevant.

Abdominal palpation revealed exquisite tenderness over McBurney's point; spasm over the right lower rectus, release tenderness over the lower abdomen, with a sensation of mass on deep palpation over the appendix area. Differential blood count showed 24,000 white blood-cells, of which 89 per cent. were polymorphonuclears.

Exploration through a Kammerer incision revealed a medially situated gangrenous appendix. Its mesentery was hæmorrhagic and swollen. After mobilizing the appendix it was noted that emanating from the caput coli, extending around to its undersurface and then upwards and medially, there were a series of black streaks running parallel and then converging, which were about the size of the lead of a thin pencil and with very much the same appearance. These streaks were interpreted as veins, the seat of an acute phlebitis with possible thrombosis. The appendix was ablated after removing the meso-appendix widely and permitting the vessels to bleed freely and ligating these individually. The inflamed veins were then dissected out by freeing the cæcum and turning it upwards. This was effected by dividing the posterior parietal peritoneum at its outer and inferior margin although in part the cæcum was mobile. These veins were excised with the cellular tissue surrounding them, until free bleeding from the divided vessels was noted. This occurred at about the junction of the ileocæcal with the ileocolic vessels. The abdomen was drained with rubber dam at the point where the retroperitoneal space was invaded. The patient made an uneventful recovery except for a rise of temperature to 102° on the sixth, eighth and ninth post-operative days in conjunction with a chilly sensation on the first of these.

The specimen showed acute phlegmonous appendicitis with an acute inflammation of the mesentery in which numerous thrombi in the veins in

combination with an endarteritis could be demonstrated. The excised retro-cæcal veins revealed an acute phlebitis. The vessel wall microscopically showed marked evidences of acute inflammation, breaking up of the internal elastic membrane with infiltration of the vein wall with numerous leucocytes. Cultures of the excised veins showed *B. coli*. No bacterial stains on these veins were carried out.

Colp,* in 1926, on the basis of an analysis of upwards of two thousand cases of acute appendicitis in all its forms, with particular reference to the significance of chills came to a series of conclusions, one of which states: "When a chill is present the possibility of pylephlebitis should constantly be borne in mind, and the appendicular mesentery should be carefully investigated for evidences of suppurative phlebitis." Thalhimer† previously cautioned likewise. Doctor Klemperer, pathologist of Mt. Sinai Hospital, tells me that in about 10 per cent. of the cases of acute appendicitis thrombi are noted in the veins of the mesentery of the appendix. The incidence of pylephlebitis is approximately 3/10 of 1 per cent. It is at once obvious that phlebitis in the mesenteric veins does not necessarily presage an ascending venous phlebitis. The writer would not want it understood in view of this fact, as his reason for presenting this patient, that he was an adherent of the more radical venous ligations in cases of suppurative appendicitis whenever accompanied by chills. The case presented must be relegated to a slightly different category inasmuch as the process had extended beyond the anatomical limits of the mesentery and was so readily demonstrable. He did not wish to leave the impression that this result falls in the general class of *post hoc ergo propter hoc*. He did wish to call attention to the general principle as exemplified in this case, namely that when the lesion is found, and it should be sought for, and when the procedure, as here, can be carried out without detriment to the patient, it is well worth while.

DR. HAROLD NEUHOF said that there have been many experiences with cases in which chills accompanying severe appendiceal lesions have been secondary to phlebitis of the vessels of the mesenterium and in which local excision of the diseased appendix has not sufficed to cure the patient. On the other hand, there are cases in which phlebitis was undoubtedly present and left behind by simple removal of the appendix and in which the patients survived. Perhaps because of drainage into the liver the clinical course of cases of phlebitis in the distribution of the portal vein is apt to be different from that of phlebitis involving veins that drain into the general systemic circulation.

DR. RALPH COLP said that thrombosis of the ileocæcal veins in cases of acute appendicitis with chills bears an important relationship to the occurrence of portal pylephlebitis. Dr. A. Gerster first suggested incision and drainage of these thrombosed veins in acute appendicitis, and subsequently Wilms advised excising the involved veins of the ileocæcal angle. However, it must not be forgotten that this procedure might result in a cæcal fæcal fistula. For this reason Braun suggested ligating the ileocolic vein in those cases in which the pathology at the time of operation and the clinical history suggested the possibility of pylephlebitis.

* Colp, Ralph: ANNALS OF SURGERY, vol. lxxxv, p. 257, Feb. 1927.

† Thalhimer, William: Arch. Surg., vol. viii, p. 658, March, 1924.

TREATMENT WITH IRRADIATED PETROLATUM

This procedure is not difficult because the thrombosed vein can usually be felt as a cord running upward from the cæcum toward the mesentery to the right of the spine. If, however, the infection has already spread beyond the ileocæcal vein, very little can be gained by the ligation of the portal vein as suggested by the experimental work of Neuhof. This portal vein was ligated in three cases of portal pylephlebitis at Mt. Sinai Hospital, New York, and while the patients did not die from the effect of ligating the vein, they did die as a result of liver destruction due to infected emboli already present in the liver at the time the vein was ligated.

TREATMENT WITH IRRADIATED PETROLATUM

CASE I.—*Pleural Fistula Following Operation for Chronic Empyema.*—DR. HOWARD LILIENTHAL presented a woman about twenty-eight years old, who had been operated upon for chronic empyema which began at the age of four and which then healed. She had been first seen by the reporter November 11, 1929, when there appeared to be a sacculated empyema connecting with a bronchus; there was blood streaking with expectoration and elevation of temperature. She was operated upon by another surgeon who drained the cavity thoroughly but in spite of this the wound refused to heal and it was suggested that an anterior rib resection for complete thoracic compression should be performed but the patient refused consent because of the deformity which would follow. After this, April 24, 1930, he saw her again when there was an undrained pocket and a thoracic fistula. He operated upon her April 29, 1930, using the electric scalpel. A long incision was made above and another below the sinus, mobilizing the lips of the former wound. With blunt retraction the depths could be explored and he incised the dense membrane which held the lung rigid, peeling away much of the membrane and entering an abscess cavity in the lung which obviously connected with a bronchus.

He closed the wound except for a tiny drainage tube with a rubber valve. By October 22, about six months later, the cavity had greatly shrunk in size, its capacity being only about 5 cubic centimetres. The tube was removed but the sinus refused to close, a small discharging fistula about 4 inches in length remaining. Early in January, 1931, he injected irradiated petrolatum using a very small purse silver cannula the shape of a probe which he carefully worked into the sinus apparently to its upper extremity. Next day the sinus was closed and the patient felt well. Three weeks later it reopened but after one more injection of irradiated petrolatum it again closed and she has remained well ever since.

CASE II.—*Suppurative Tenovaginitis of the Palm.*—DOCTOR LILIENTHAL presented also a woman in her fifties, who was first seen by him in consultation January 24, 1931. She was in good health. Three days before she had pricked the palmar surface of her middle finger over its middle phalanx with a wire. The puncture did not bleed but twenty-four hours later there was pain and swelling which progressed so rapidly that when he saw her the finger was red, swollen and extremely tender and the back of the hand was cedematous. There had been no chills and there were no enlarged lymph-nodes. Temperature was 101.5°. Two hours later at Mt. Sinai Hospital under general anæsthesia a rubber tourniquet having been placed about the forearm, and after disinfection with iodine, he made a small but deep incision over the puncture mark on the volar space of the middle phalanx. No pus was found. Two sagittal incisions were then made through the

tissues over the proximal phalanx, one at each side of the tendon. About 10 cubic centimetres of thin pus were evacuated, coming from the distal part of the incision. The tendon sheath was freely opened but no pus was seen coming from the region of the palm, only from the distal part of the finger. The wounds were filled with warm, liquid, irradiated petrolatum and the entire hand dressed with dry gauze and placed on a splint in moderate extension with the fingers partly flexed. There were no packings of any kind and no tube was used. Little pain followed this operation and the wound was not dressed until forty-eight hours later. There was no pus although the proximal wounds were explored by a probe but there was still œdema of the back of the hand and slight tenderness in the palm. The parts were cleansed with ether and the hand and arm immersed in a saturated solution of magnesium sulphate. The temperature did not rise higher than 99° and the pain was trivial.

January 28, 1931, four days after the first incision, with the same technic, he made an opening $\frac{3}{4}$ inch long through the palm in the line of the tendon, evacuating a little opalescent serum from the sheath which was freely opened. The wound was filled with irradiated petrolatum as at the former procedure. At this time the earlier wounds were separated with dissecting scissors for purpose of examination. The laboratory had reported streptococcus hæmolyticus from the specimen sent at the former operation. The short course of the after-treatment was without incident. Finger exercises were begun two days after the last procedure. Healing was rapid and complete with 90 per cent. or more of function.

He had never seen an infection of this kind yield so promptly and feels that the treatment by the irradiated petrolatum was of prime importance.

CASE III.—Tenovaginitis of Anterior Tendons of Foot and Leg. Incision and Drainage.—As further illustrating the use of irradiated petrolatum, Doctor Lilienthal presented a man, aged about sixty, who was first seen by him March 29, 1931. For a few days the patient had had pain at the anterior aspect of the ankle and two days before he saw him a swelling had appeared, which Doctor Moschcowitz aspirated, withdrawing opalescent fluid diagnosed as coming from a tendon sheath. When Doctor Lilienthal saw him the skin was reddened and there was a fluctuating elevated area about 1½ inches in diameter. No femoral lymph-node enlargement was present and no lymphangitic streaks. Temperature 101°. Because of the rapid progress of the case he operated the same day.

Elastic constriction of the thigh was made so as to have a clear field for operation. Through a sagittal incision granulation tissue was first encountered and beneath this there was a free discharge of pus which proved to have come from the anterior tendon sheaths, especially that of the anterior tibial muscle. It was necessary to prolong the incision upward and downward for nearly 3 inches and a large quantity of opalescent pus was discharged from within the sheath. A specimen for culture was taken. The wound was filled with melted irradiated petrolatum without packing but a piece of gauze was laid upon the wound and held in place by a large elastic compression dressing.

There was immediate relief; discharge was minimal and the patient left for his home a few days after the operation where treatment was continued. Ten days later he was able to come to the office for dressings but the wound healed slowly and he was not discharged until two months after the operation. Still, the man was up and about after three weeks and at no time was there any sloughing, extension of infection, or other complication. The report from the laboratory was pure culture of streptococcus hæmolytic. (Beta.)

These three cases exemplified what he had observed in more than a year of the treatment of septic wounds with ultraviolet irradiated petrolatum.

In chronic sinuses without the presence of a septic foreign body he had had excellent results. In accelerating the healing of draining sinuses following cholecystectomy the petrolatum has been of great value. He had used it with satisfaction in nearly all wounds in which the petrolatum could be retained. Large cavities, however, such as those connected with pulmonary abscesses, had not responded in the striking manner which he had noted in narrower tracts whose ultimate recesses are difficult to reach. He had never seen any bad effects from the use of this remedy. In one case, that of an amputation of the thigh still under treatment, previous intensive therapy by X-ray had produced an indurative condition of all the soft parts which for months had been healing very slowly and in which irradiated petrolatum has been of service only to diminish suppuration. It did not seem to have hurried the actual obliteration of the infected cavity nor had any other agent been more successful. At present there is continuous and great improvement.

Petrolatum without irradiation has long been used in septic wounds of surgery. In the early days vaseline and cosmoline were used for almost every kind of dressing. The mere fact that it has been almost discarded seems to be an indication of failure while the applicability of the irradiated variety seems to be constantly increasing.

The two cases of acute infection of the tendon sheaths by hemolytic streptococcus are remarkable examples of what has been accomplished. He did not remember ever to have seen infections of this type eradicated with such speed and with so little reaction.

The material is non-poisonous while other direct antiseptics may produce toxic symptoms in subjects who have idiosyncrasies. Cleansing the wound with ether before instilling the petrolatum adds to its efficiency. A flexible metal cannula of very small size attached to a hypodermic syringe is a convenient instrument for this purpose.

Doctor Eising has written on the physics and chemistry of irradiated oils and his contributions may be consulted by those who seek full information.* †

DR. EUGENE H. EISING (by invitation) said that the physical, chemical and bacteriological aspects of irradiated petrolatum were of great interest but that he would confine his discussion to the clinical side of the cases presented. He believed that the cases which he had treated together with those reported to him either verbally or in writing, as having been cured, numbered close to two thousand. In regard to the case of chondritis of the rib

* Eising, E. H.: Therapeutic and Physical Properties of Ultraviolet Irradiated Petrolatum. *ANNALS OF SURGERY*, vol. xciii, No. 6, pp. 1231-1253, June, 1931.

† Eising, E. H.: Ultraviolet Irradiated Petrolatum—Its Physio-chemistry and Bacteriology. *Med. Jour. and Rec.*, vol. cxxxvi, No. 6, pp. 251-253, September 21, 1932.

reported by Doctor Morris, quite a number of such cases have been reported cured by injecting liquefied irradiated petrolatum into the sinus. Occasionally, this must be repeated two or three times; it is essential that the entire sinus be filled and that no air bubble be left at the extremity of the sinus. Doctor Morris will probably effect a cure by persisting in this method. Doctor Morris's case of abdominal fistula is quite similar to the first case in which he used this material. Doctor Lilienthal's case of suppurative tenovaginitis of the finger and palm was the first case to be treated in that manner at the time of operation. He felt justified in asking Doctor Lilienthal to treat this case by flooding the open tendon sheath with warmed irradiated petrolatum, because he had previously treated a traumatic case, in which, following an automobile accident, the palm of the hand was laid open and the tendon sheaths exposed. This case had been sutured and subsequently became infected. The entire wound had to be opened and irradiated petrolatum was flooded into the wound. The infection cleared up at once and there was no extension of the infection. This case demonstrates the bactericidal action of this material. The bactericidal action and stimulation to granulation are also well demonstrated in large abdominal wounds that have broken down after laparotomy. These purulent wounds may be flooded with irradiated petrolatum and covered with gauze. At the second, third, or sometimes fourth application, the wound will be entirely free from discharge and can be closed, in bed, with a few silkworm sutures. Many weeks of convalescence may thereby be saved and result in a much stronger abdominal wall than would have resulted by healing by granulation.

DR. WILLIAM BIERMAN (by invitation) said that about two years ago Doctor Eising asked him to analyze this product. At first it appeared as if whatever clinical value it had was due to some ultraviolet irradiation. No ultraviolet irradiation, however, could be found. It fogged a photographic plate but if the petrolatum was covered with quartz glass this did not occur. This indicated there was no irradiation which could go through quartz. The therapeutic effect was due to some change in the jelly produced by the irradiation. It is certain that there occurs some chemical change in the substance as a result of ultraviolet irradiation.

COMMON BILE-DUCT INJURY WITH IMMEDIATE REPAIR

DR. SEWARD ERDMAN presented a man, aged sixty years, who was admitted to the Medical Service of the New York Hospital, March 12, 1932, with a history of over one year's duration of epigastric distress, "heart burn," gaseous eructations chiefly soon after meals. For the past two months the pain had become much more severe and persistent, no longer related to meals nor relieved by sodium bicarbonate. There was occasional vomiting, loss of weight and strength, dizziness and sallowness of the skin.

Sixteen years ago, with a somewhat similar train of symptoms, he had been under medical treatment for "gastric ulcer" (?) and had been relieved by several weeks of rest and ulcer diet. In March of this year he was put on a Sippy diet but failed to improve and after ten days, developed severe epigastric pain and tenderness, with chill and fever of 105°. Irregular chills and a temperature of 101° to 102° continued for about two weeks.

COMMON BILE-DUCT INJURY WITH IMMEDIATE REPAIR

X-rays of the gastro-intestinal tract were negative. The gall-bladder failed to visualize with the dye test. Icterus index was from 13 to 19. Leucocytes, 14,400; 88 per cent. polymorphonuclears.

Operation, April 12, 1932.—A small very much thickened gall-bladder was found high up under the liver, completely covered with dense omental adhesions. Four facettted gall-stones about 1.5 centimetres in diameter were in the gall-bladder. The gall-bladder was removed, beginning at the fundus, because the ducts were buried. The proximal half of the gall-bladder was embedded in almost leathery adhesions in the liver bed, due, as the specimen showed, to an old perforation and suppuration in the liver bed. Sharp dissection was required to separate the gall-bladder from this part of the liver bed. During this procedure the hepaticus was unwittingly cut across. As this was not recognized at the instant it was natural to assume that the small remaining stalk of the now completely free gall-bladder was the cystic duct, and this was now ligated and divided. Inspection of the depths of the wound, however, showed bile flowing freely from the open end of the hepaticus which had been cut across obliquely. The ligated end of the common duct lay fully $2\frac{1}{2}$ centimetres distant.

After such mobilization of the common duct as was possible, an end-to-end suture of the ducts was made over a T-tube, using seven interrupted sutures of No. 00 chromic catgut. The wound healing and the convalescence were rapid and the stools showed bile until the tenth post-operative day, when all bile came out through the tube and the stools were acholic.

Attempts to relieve the obstruction by clamping the tube merely caused cramps and leakage around the tube. Syringe injections and attempts to insert filiform bougies were alike unsuccessful. On the twenty-eighth day a lipiodol injection was made and the X-rays revealed that no fluid passed beyond the limits of the distal end of the T. The patient was sent home for a month, with a complete external biliary fistula.

Upon readmission to the hospital in June, it was felt that simply drawing out the T-tube would hardly suffice to relieve a common-duct obstruction which had persisted more than $2\frac{1}{2}$ months. June 24, 1932, a second operation was performed and the ducts explored, and found to present a smooth and completely healed union, except for the round hole through which the T-tube had its exit.

The tube was withdrawn, and the distal portion found filled with a thick brownish mud. The duct distally contained some of this same material but admitted a probe through into the duodenum. A very small tube was now placed in the hepaticus for a few days, after which leakage occurred into the dressings until the twentieth day when the wound became dry and rapidly and permanently closed, and the stools became normal in color.

Up to the present the condition of the patient has been perfectly satisfactory, but it is much too early to feel sure that stricture may not occur at the site of the anastomosis.

The blockage of the duct while the T-tube was still in position led to many misgivings as to whether the anastomosis might have given away: nor is it easy to see how one can go about clearing an obstruction in the distal portion of the T without resorting to operation.

This case shows that an end-to-end approximation may be secured by an immediate repair, although the defect measured 2.5 c.m. Merely to bridge over such a defect with a T tube, is more likely to result in cicatricial stenosis of the fibrous channel, thus formed.

DR. CARL EGGERS remarked that in such cases as Doctor Erdman had presented, in which there is a great deal of infiltration with obliteration of normal landmarks, an injury to the common duct is understandable. Injury to the duct, and even complete division, has resulted from operation in very simple cases. Especially since cholecystectomy in a retrograde manner, beginning with ligation and division of the cystic duct, has become the operation of choice with most surgeons, this accident has been reported more frequently. He had had such an unfortunate result in a case about two years ago. The operation was very easy in a thin young woman in whom it was possible to evert the liver and expose the gall-bladder and ducts. He doubly ligated and divided what he believed to be the cystic duct and removed the gall-bladder without difficulty. While ligating the vessels it seemed to him that the strand was rather thick, but on inspection found nothing wrong. There was no bile leakage. The abdomen was closed without drainage.

On the third day the patient became jaundiced and this jaundice increased. The question of ligation of the common duct was considered but dismissed because the stool continued to have normal color. Except for the presence of jaundice, the convalescence was uneventful, and the patient was discharged to the care of her family physician. The tentative diagnosis was hepatitis or ligation of an accessory duct. She remained under the care of her physician and was not seen again for two months when she complained of loss of appetite, tired feeling, and itching of the skin. She stated that her stool was clay colored. Operation was advised and performed three months after the original operation. There were extensive adhesions under the liver which made identification of structures difficult. By mobilizing the duodenum the lower end of the common duct was identified, and it was also possible to free the upper end of the hepatic duct just under the liver. It was much dilated. The mid-portion of the common duct had either been obliterated or was absent. By means of a T-tube a connection was established between the upper and lower ends and the abdomen then closed. On account of excessive oozing during operation a transfusion of 500 cubic centimetres of whole blood was given. Some bile drainage became established, but the patient began to bleed and in spite of all counter measures she expired on the fifth day.

The explanation for such accidents is difficult. It is hard to realize that ligation of the common duct has been done in such easy cases. The most satisfactory explanation is probably the assumption of abnormal duct arrangements. That there is great variation in the arrangement of the ducts is well known. Beaver, of The Mayo Clinic, on the basis of fifty-seven careful dissections, found that only 58 per cent. correspond to what we usually call the normal arrangement. It is the type in which the cystic duct runs parallel to the hepatic or common duct and is bound together with it by a fibrous union, which is most liable to accidental division. It is often almost impossible to separate them and it is conceivable that one may pick up and ligate both instead of only one. The best way to prevent this seems to be by

COMMON BILE-DUCT INJURY WITH IMMEDIATE REPAIR

beginning dissection in a cholecystectomy at the fundus and work towards the cystic duct. This is the method he has followed since his unfortunate experience.

DR. HOWARD LILIENTHAL, to show one thing that can happen, made a diagram upon the blackboard showing how it is possible by traction upon the gall-bladder during its removal to lift the common duct into a sharp angle which makes a Y with the cystic duct, and how this may not be observed by the operator who includes the two legs of the Y in his ligature. If this ligature is of slowly absorbing material dangerous and even fatal jaundice may at once supervene.

DR. DEWITT STETTEN recited the case of a woman, sixty-four years old, with a somewhat thickened gall-bladder, containing a solitary ovoid calculus, and with a fistulous communication between its fundus and the duodenum. After separating the adhesions between the fundus of the gall-bladder and the duodenum and closing the opening in the duodenum, he proceeded in the usual manner to perform a cholecystectomy from above downward. The cholecystectomy was unusually easy. After ligating and dividing the mesentery of the gall-bladder, a rather larger lumen than usual was noted in the ligature and, on removing the ligature, it was found that the hepatic duct had been completely divided transversely just above the entrance of the cystic duct, the accident apparently due to an anomaly that is not uncommon—namely, a parallelism of the cystic and hepatic ducts, under which conditions a division of the hepatic duct can very easily occur. The nature of the mishap was immediately recognized and an end-to-end anastomosis of the divided duct was performed without much trouble and without the use of a tube. A cigarette drain was introduced just below the suture line. The patient made an uneventful recovery with only slight biliary drainage for a short time after the operation. Thirteen years later Doctor Stetten saw her again. At this time she was complaining of what appeared to be a mild attack of cholangitis with slight jaundice and elevation of temperature. She recovered from this under medical treatment and, as far as Doctor Stetten knew, she is still alive and well, eighteen years after the duct injury and repair.

DR. JOHN F. ERDMANN said that all surgeons who have practised for any length of time have had such an experience. Two such accidents had already occurred to him and such an occurrence is distinctly unsettling to the surgeon. He had repaired seven injuries to the common duct in other men's patients with the major portion of them recovering. In the first one in which he had done the after repair the patient died, but this was due to her delay in accepting operative advice. It is not material to him whether he approached the duct from above or below, but it has been his custom in the past ten years to approach it from below. Previously he had advised approaching it from above. Where there is any marked infiltration in the neighborhood of the cystic and common duct removal from above downwards should be the policy.

TETANUS FOLLOWING APPENDECTOMY

DR. SEWARD ERDMAN presented a man, aged thirty, who was operated upon by him at the New York Hospital, immediately after admission, March 21, 1932, for acute appendicitis of less than twenty-four hours' duration. The appendix was found in a stage of early but complete gangrene and was removed without rupture through the McBurney incision.

The peritoneum was closed, but a drain was placed down through the muscles. The post-operative course and healing of the wound proceeded smoothly until the evening of the ninth day after operation, when after chewing gum all the afternoon, he complained of slight stiffness of his jaws, but could open the jaws fully. His temperature had been normal up to this time; the wound was healed save for a small granulating area at the site of the drain; and he was to be allowed out of bed on the morrow.

The patient now recalls that later during the same night he felt some "twitchings" and pain in the region of the wound.

The following morning, he was unable to open his mouth and had difficulty in swallowing fluids; the temperature rose to 101.8° . Leucocytes, 11,000, with 69 per cent. polymorphonuclears. The picture was now that of a full-blown case of tetanus, on the morning of the tenth post-operative day, with tightly clenched jaw, generalized muscular rigidity, with the back arched and the head drawn back in opisthotonus. The abdominal muscles were rigid; the right leg was rigidly extended, while the left leg was held flexed. Clonic spasms of the right lower extremity occurred frequently, lasting for about one and a half minutes, and during these spasms the opisthotonus was exaggerated. For over forty-eight hours these attacks recurred at intervals of from ten to thirty minutes.

Treatment was at once instituted. Within less than fourteen hours from the first complaint of jaw stiffness, a lumbar puncture was performed and ten cubic centimetres of spinal fluid withdrawn, which was clear, containing only three cells (polymorphonuclears) per cubic millimetre. Immediately 10,000 units of tetanus antitoxin were given intraspinally and at the same time 20,000 units intravenously. At six-hour intervals two more intravenous injections were given of 20,000 units each and a subsequent one of 10,000.

Twenty-four hours after the first intraspinal dosage, lumbar puncture was again performed and 20,000 units injected intraspinally. The spinal fluid now was turbid and contained very many cells. Thus at the end of forty-eight hours after the first onset, he had received 100,000 units; *i.e.*, 30,000 intraspinally and 70,000 into the vein. During the following day (third of the disease) he received 20,000 units intravenously. On the fourth day two injections of 10,000 each were made intramuscularly in the area about the appendectomy incision. No serum was given on the fifth and sixth days, but on the seventh, eighth, ninth, tenth and twelfth days he received 10,000 units intramuscularly in the abdominal muscles, and finally on the fifteenth day 1500 units. Thus in total he received 191,500 units of tetanus antitoxin, and developed only a mild serum sickness.

Chloral, sodium bromide and morphine were freely administered but failed to control the spasms.

By the fourth and fifth days, although the trismus, the sardonic grin, the opisthotonus and rigidity continued, the clonic spasms were less frequent and severe, occurring about every thirty to forty-five minutes. At this time he developed severe paroxysms of coughing and cyanosis perhaps from his difficulty in swallowing fluids, and getting rid of mucus. The temperature continued between 100° and 102.5° . After the seventh day definite improve-

ment became evident and the clonic spasms ceased entirely about the tenth day. From the eleventh day onwards there was gradual relaxation of the muscles and the mouth could be opened slightly and convalescence from tetanus seemed assured.

On the tenth day the right parotid gland became swollen and tender, and Stenson's duct was blocked with thick white mucilaginous secretion, not containing pus-cells. Despite efforts to clear the ducts and the application of external heat suppuration set in and six days later two incisions were made near the angle of the jaw, several ounces of pus obtained, and thereafter for ten days there was much discharge of pus and slough, which delayed the convalescence. The patient was discharged on the thirty-second day after the onset of the tetanus. It seems probable that the parotitis may have originated from inspissation of saliva, and blocking of the duct, owing to the lockjaw and the limited and purely fluid nourishment.

At no time were tetanus bacilli recovered from the appendix wound, despite repeated cultures and a limited débridement. The suppurative parotitis pus yielded *Staphylococcus aureus*. Progress after discharge from the hospital was very rapid and the patient gained thirty pounds in weight within two months. He appears now to be perfectly well.

Comment.—The favorable outcome was due in no small measure to Dr. Frank M. Davis, one of the house surgeons, who administered the treatments and devoted himself unstintingly to the care of the patient, Dr. Davis writes "if the enormous amount of serum seemed excessive of theoretical requirements, they did not dare fail to utilize every therapeutic measure available, while the symptoms were so persistent."

Jonathan Wainwright, in 1926, reviewing all cases in British and American literature for the last twenty years, encountered 365 cases of post-operative tetanus, including seventy-eight oöphorectomies; thirty-eight inguinal hernias; thirty-seven appendectomies; twenty-nine hysterectomies and ten gall-bladder operations. Wainwright is stoutly opposed to intraspinal injections, but believes in the necessity of giving from 30,000 to 50,000 units intravenously and intramuscularly, and early. He quotes Friedlander, of Cleveland City Hospital, as giving an initial dose of 78,000 by vein; one patient received by vein and muscle a total of 755,000; three patients received over 600,000 and eight patients received over 200,000 units.

Our patient lived in a truck-farming area of Long Island and worked in his own garden. Is it possible that he harbored tetanus bacilli in his intestinal tract?

DR. GRANT P. PENNOYER stated that post-operative tetanus is fortunately a very rare disease. It has a mortality of about 85 per cent. They had had two cases at Roosevelt Hospital within the past ten years, one following a simple hemorrhoidectomy, the other a mastectomy. The mastectomy was done to get rid of a foul, malignant ulceration. Both these cases died within forty-eight hours after the onset of symptoms despite vigorous treatment. It is the most fatal of all surgical complications. It is so rare that many experienced surgeons have never seen a case, but it does occasionally occur

most unexpectedly after most any operation. The only hope for the patient lies in very prompt recognition and vigorous antitoxin treatment. It usually begins between the fourth and fourteenth post-operative days, never before the second day, rarely after the eighteenth.

The first signs are usually stiffness and perhaps slight pain on motion of the jaw muscles, or perhaps the neck muscles are the first to be involved. This increases slowly in mild cases with a long incubation period, very rapidly in fulminating cases with a short incubation period. The jaws and neck become rigid and soon generalized tonic convulsions follow and usually death. There is usually no fever, no rise in the pulse rate, no swelling or indication of infection, no objective signs of a serious complication developing. The patient's story of a stiff jaw or neck are ignored and the chance for a recovery lost by delay in the onset of treatment. In amputation stumps the disease may be localized to the stump muscles at first and the first signs of the disease may be local twitchings in the stump. Peterson summarized 150 cases collected from the literature and many more have been reported since.

The source of the infection has been much discussed. Catgut and kangaroo tendon have been blamed, and in rare cases proven to be the source. Probably with improved methods of suture preparation this is now rarely the case.

The intestinal tract of the patient is the most probable source. The bacillus and its toxin are harmless in the intestinal tract, but once given entry into the body tissues the situation is very different. Competent observers have found tetanus bacilli in human stools in as high as 5 per cent. of cases, and the incidence in stable workmen may rise to 20 per cent. The appendix stump, the clamped hemorrhoid or merely the traumatized intestinal wall may be the portal of entry. Many of the cases have clean operative wounds and it is impossible to prove the source or location of the infection. Abdominal operations are more frequently followed by tetanus than any other type.

In certain cases there is evidence that tetanus spores have lain dormant perhaps for years in the tissues and were simply activated by the trauma or metabolic changes incident to the operation. The possibility of this must be considered in patients who have had tetanus and recovered.

The rôle of symbiosis with pyogenic and saprophytic organisms which consume oxygen and favor the anaërobic growth of the tetanus bacilli is also, undoubtedly, very important.

There are certain general facts about tetanus which should be borne in mind in a discussion of post-operative tetanus. The disease is more frequent in this region—that is, the Hudson Valley, Long Island and New Jersey and other Atlantic States—than elsewhere in the United States. The spores are the most resistant known. Active bacilli have been obtained without difficulty from a dry nail dipped in a tetanus culture eighteen years before. How much longer the spores will live has not been proven. Spores have been known to survive a whole hour of boiling, and fifteen hours of immersion in 5 per cent. phenol. Hence this disease is not going to disappear.

HERNIA INVOLVING THE BLADDER

The toxin is the most virulent poison known. A dose of 1/250 grain of toxin is sufficient to kill a 150-pound man. A case is on record of the mere prick of a needle, which had been dipped in a sterile toxin, filtered free from bacteria, nearly causing the death of a laboratory worker. As the antitoxin is ineffective once the toxin is in combination with the nerve-cells, it is easy to see why the disease is so fatal, except when recognized early.

The treatment of post-operative tetanus is very prompt administration of large doses of antitoxin intravenously and intraspinaly, followed by intramuscular injections. Any recognized collection of pus should be thoroughly drained. Antispasmodics, especially chlorotone by rectum, are helpful.

The antitoxin administered is entirely eliminated in ten to fourteen days. If the tetanus bacteria are still active and no more antitoxin is administered, the disease will recur. Cases of late death are reported, after the disease had been arrested by repeated doses of antitoxin, due to neglect of this fact.

DR. FRANK L. MELENEY said that on the surgical service at the Peking Union Medical College in China, two cases of tetanus occurred following bed sores and one case developed after a gunshot wound of the abdomen. In these cases tetanus bacilli were found in the stools. This led to a study of the incidence of tetanus spores in the intestinal tract of Chinese patients. TenBroeck found that 37 per cent. of the Chinese patients in the hospital had tetanus spores in the stools. During the recent World War, Tulloch, in England, found that soldiers from the front had an incidence of 33 per cent., while people in cities, not near the soil, had about 3 to 5 per cent. The speaker inquired if any attempt was made to examine the stools of his patient for this organism. This would seem to be the most likely source, but if after careful search they were not found in the stools, the catgut used during the operation would be under suspicion for wound infection with tetanus bacilli from inadequately sterilized catgut has undoubtedly occurred.

DOCTOR ERDMAN, in closing the discussion, said that the stools were not examined, although it was assumed that the source of the infection was from intestinal contents. Numerous cultures were made of the wound, which failed to show tetanus bacilli. The patient lives in one of the truck-garden areas and spends all his leisure time on his hobby, which is working in the soil. Tetanus is less common now in cities than it was formerly because automobiles have replaced horses.

HERNIA INVOLVING THE BLADDER. VISUALIZATION BY CYSTOGRAM

DR. SEWARD ERDMAN presented a man, aged fifty years, who was admitted to the New York Hospital, October 9, 1931, on account of bilateral recurrent inguinal hernias, both of which had recurred four times. The first bilateral operation was in 1918 at the Hospital for the Ruptured and Crippled, the second and third repairs were performed at the East New York Hospital, during the following ten years; and the fourth repair, some five months ago at the Beth Israel Hospital, had recurred almost immediately.

Examination on admission showed a moderate-sized recurrence on both sides, larger on the right. The testis on the right side was completely atrophic, but the left was normal in size. Owing to the site of the recurrence on the right side, directly over the spine of the pubis, it was rather to be expected that the bladder might be involved, and suggested that a cystogram of the bladder might be used to confirm this suspicion. A 10 per cent. sodium iodide solution was injected into the bladder and X-rays taken, which showed very definitely a portion of the bladder protruding out through the hernial ring.

In view of the frequent recurrences, it was decided wiser to repair only

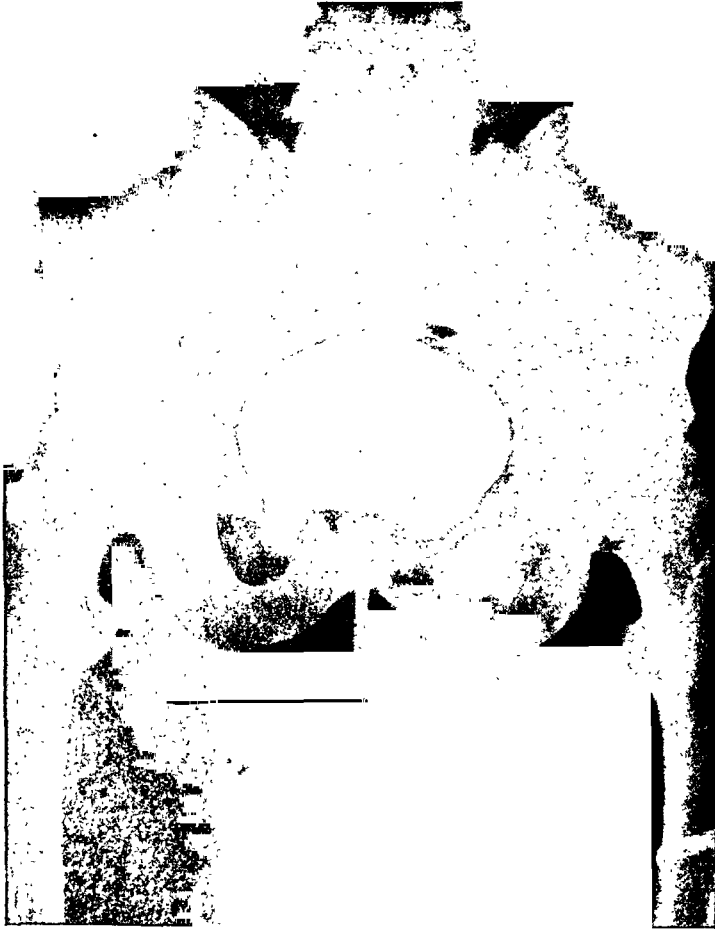


FIG. 1.—Cystogram showing definite protrusion of bladder through the Direct Hernia ring on the right, with merely a bulging into the Left Hernia ring.

the right-sided hernia at this time, leaving the left recurrence for repair at a later date, and indeed, this latter has been only recently done by the resident at the New York Hospital. At operation on the right side, a protrusion of the bladder was found as indicated in the X-ray, and forming a major portion of the hernia. (Fig. 1.) After careful separation from the bladder the sac of the hernia was closed in the usual manner. The hernial ring consisted of a large defect in the aponeurosis and fascial layers directly above the spine of the pubis, a common type of direct recurrence, which I name an "inner angle recurrence." This defect was closed by using three strips of fascia lata for sutures after the Gallie method.

DIAGNOSIS AND TREATMENT OF ACUTE PHLEBITIS

This case was presented merely to call attention to a method of diagnosis, which he had not seen described in the literature, but one which might have a field of application helpful to the surgeon in forewarning him of the presence of the bladder in the hernia and thereby still further limit the instances of unintentional injury to the bladder at operation. In nearly every reported series of hernia operations such injuries have occurred in a number of cases, sometimes with serious if not disastrous results.

DR. BRADLEY L. COLEY said that the hernias in which the bladder may most frequently be injured are: (1) Recurrent inguinal hernias; (2) direct hernias; and (3) large indirect scrotal hernias. He showed prints of a radiograph of an enormous scrotal hernia in which a cystogram and barium enema were made coincidentally. In this case the presence in the sac of a large part of the colon was established, while the bladder was found not to occupy any portion of the sac. It seemed to him that Doctor Erdman's suggestion of taking a cystogram in these difficult cases of hernia should be more generally adopted, and the presence or absence of this complication established prior to operation. Injury to the bladder, while a not infrequent important complication of the surgical treatment of hernia, is not apt to be followed by serious results, if the injury is recognized immediately and carefully repaired.

THE DIAGNOSIS AND OPERATIVE TREATMENT OF ACUTE PHLEBITIS COMPLICATED BY GENERAL SEPTIC INVASION

DR. HAROLD NEUHOF read a paper with the above title for which see p. 808.

DR. FREDERIC W. BANCROFT said that there are some methods which can be utilized in the early treatment of phlebitis before it becomes septic that may prevent the necessity of ligation. The intravenous injection of an aqueous solution of 0.5 per cent. of gentian violet very frequently causes marked improvement. In fourteen cases where this treatment had been used the patient was very definitely improved, as shown by a drop in temperature within twenty-four hours, and in some cases of femoral phlebitis a decrease in size of from one to two inches in circumference of the thigh within two days. About fifty cubic centimetres of this solution is injected and it may be repeated after forty-eight hours if there is no marked improvement. In the cases followed where this treatment has been used there has been very little if any residual swelling of the leg in cases of femoral phlebitis. When the phlebitis has become definitely septic, Doctor Bancroft is thoroughly in accord with Doctor Neuhof's use of proximal ligation followed by excision of the infected vein where it is possible without too great operative shock.

DR. JOHN H. GARLOCK stated that most surgeons would agree with Doctor Neuhof regarding the necessity for surgical intervention in septic phlebitis and thrombophlebitis. This condition is to be sharply differentiated from the ordinary post-operative phlebitis of the femoral vein, which, in the majority of instances, is a non-surgical condition. That a septic infection of a

vein may present a rapidly fulminating course and end fatally in spite of early recognition and early surgical attack is evident in the following case:

This patient was seen in consultation six days after her injury, which consisted of a small laceration over the anterior aspect of the proximal phalanx of the right index finger. An infection developed which was incised under general anaesthesia by the attending physician. The infection seemed to be definitely under control, when suddenly, exactly thirty-six hours before the patient was seen by the speaker, she experienced a shaking chill followed by a rise of temperature to 106° F. During the following twenty-four hours, she experienced repeated chills and the temperature assumed a septic course. Examination revealed a partially healed incised wound on the anterior aspect of the base of the right index finger and a slight barely perceptible tender thickening along the inner aspect of the arm just above the elbow. Her blood culture revealed innumerable colonies of *Staphylococcus aureus*. Operation was undertaken immediately on the assumption that the condition was one of septic thrombophlebitis of the brachial and axillary veins. Through an adequate incision, the axillary vein was exposed and explored peripherally as far as the wrist. The entire venous system on the mesial aspect of the arm and forearm was the seat of an extensive thrombophlebitis. The veins were filled with a purulent thrombus. A careful dissection was done, excising the main veins and all their tributaries. The axillary vein was ligated about an inch and a half above the thrombus. Free bleeding occurred above this point. In spite of this radical operation, the patient continued to go downhill and died four days later. Autopsy showed multiple embolic abscesses confined mainly to the lungs.

Such malignant course in the presence of septic thrombophlebitis is unusual, and early surgical attack, in most instances will result in the cessation of the symptoms due to septic invasion of the blood-stream.

DR. FRANK L. MELENEY called attention to the rather low percentage which Doctor Neuhof had given for the incidence of infected thrombi found at autopsy in cases of septicæmia. In the wall of any abscess there are thrombosed vessels and the thrombosis may extend out into larger venules and finally involve tributaries of the large veins. The difference between a simple abscess and an infection with septicæmia would seem to be one of degree of involvement of thrombosed veins or thrombosed lymphatics. If a septicæmia is maintained, organisms are being thrown off into the blood-stream in greater numbers than the blood can kill off, for it is known that organisms in great quantity are destroyed in the blood-stream or removed from it by capillary phagocytosis. May not a septicæmia be maintained by a multiplicity of small vein thromboses as well as by a single large suppurative thrombosis? It would seem that if a search were made in cases of septicæmia for small suppurative thrombi that they would be found in almost every case.

Further, there seems to be a difference of opinion regarding the time and site of vein ligation in cases of suppurative phlebitis. It would seem to be more logical and more safe to ligate the vein first as high up as it may be done conveniently and work down toward the infection rather than to work up from the infection along the involved vein.

TRANSACTIONS

OF THE

PHILADELPHIA ACADEMY OF SURGERY

STATED MEETING HELD NOVEMBER 7, 1932

The President, DR. JOHN SPEESE, in the Chair

CALVIN M. SMYTH, JR., M.D., Recorder

PLASTIC OPERATION OF NECK, LIP AND AXILLA

DR. GEORGE M. DORRANCE presented a boy who was admitted to St. Agnes' Hospital eight years ago. He was then four years old, and had been burned over the side of the abdomen and chest. At the time of admission he had almost complete eversion of the lower lip, with the chin pulled down to the upper end of the sternum by scar tissue which was thick and keloid in type. The lower eyelids were partially everted by the pull of the neck. The little finger of the left hand was flexed upon the palm, and on the ulnar surface of the hand there was a mass of scar tissue. The left axilla had a web contracture.

The first operation consisted of freeing the chin from the sternum by dividing the scar tissue. When the chin was freed, a large denuded area resulted and this required skin covering. To accomplish this, a flap was raised from the right shoulder and sutured in place. The head and shoulder were held in place by plaster bandages. The flap covered the area very satisfactorily, but several days later it was lost.

June 9, 1925.—A double pedicle flap was outlined upon the back and raised, but the connections at each end were not divided. In three successive stages the flap was prepared for final transference. This was carried out.

The neck was prepared, and in January, 1926, the flap sutured in place, and held in position by the use of sponges and pressure. Three months later, the pedicle of the flap was divided, and the flap sutured to the neck. The result was quite satisfactory and the patient now has free motion in the neck. (Figs. 1 and 2.)

In December, 1926, a buried epithelial (Thiersch) inlay was inserted under the vermilion border of the lower lip. This became infected and the graft was lost. No improvement. October 9, 1932, a small incision was made through this scar. By undermining between the mucous membrane and the orbicularis muscle, a cavity was made which extended beyond the incision at each end. A modeling compound pattern was made approximately the size of the cavity and was inserted through the opening into the cavity. It was then found that the wound could be closed over this model. The model was then removed from the cavity. A full-thickness skin graft was removed from the thigh and sutured over the model with the skin surface towards the mold. The skin graft with model was then inserted into the cavity and the wound closed. Sixteen days later, a new incision was made along the vermilion border through the skin and through the graft. This incision permitted the model to be removed, revealing a new cavity approximately 90 per cent. covered with a full-thickness skin graft. The vermilion

border was then sutured to the skin graft on one side, and the scar tissue and graft on the other side. This corrected the lip eversion.



FIG. 1.—Showing site from which flap was obtained. FIG. 2.—Head and neck freed by flap from back; final result.

October 7, 1932, the web in the axilla was corrected by the use of the "Z" incision.

November 5, 1926, a double pedicle flap was raised from the abdomen.



FIG. 3.—Final result from pedicle flap transference.

The scar tissue upon the ulnar surface of the hand which held the little finger in flexion was excised. The finger and ulnar surface of the hand were placed under the flap. The edges of the flap were sutured to the edges of the wound

PYLEPHLEBITIS WITHOUT HEPATIC ABSCESS

on the hand and finger. This remained in place for two weeks. The pedicles of the flap were then divided, trimmed, and sutured in place. The final result is a movable finger and hand. (Fig. 3.)

PYLEPHLEBITIS WITHOUT HEPATIC ABSCESS FOLLOWING APPENDICITIS

DR. E. L. ELIASON and DR. CHAS. McLAUGHLIN (by invitation) reported the case of a man, thirty-four years of age, who was admitted to the Hospital of the University of Pennsylvania July 1, 1931, with the diagnosis of acute appendicitis. Three days before admission he had developed abdominal pain which appeared rather suddenly about the umbilicus and remained localized in this region. The following morning he experienced a severe chill accompanied by a high temperature. The admission temperature was 102° , the pulse was 100 and the respirations were 28. The entire abdomen was markedly rigid, especially in the lower quadrant. No mass was palpable. The white blood-cell count was 17,000 and the urine was negative. When the abdomen was opened an extremely large gangrenous appendix was found, extending into the right pelvis. There was a perforation at the base of the appendix with the formation of an abscess, the major portion of which was situated between the leaves of the meso-appendix, although purulent material was present in the pelvis. The meso-appendix was markedly thickened and indurated, this process involving the cæcum surrounding the appendiceal base. On severing the meso-appendix the cut vessels were seen to be definitely thrombosed, confirming the pre-operative impression. The appendix was removed with the cautery after tying the stump. Drainage was then instituted and the abdomen closed.

On the afternoon of the first post-operative day the patient had a severe chill lasting fifteen minutes, during which his temperature rose to 104.6° . The following day there was a similar chill with hyperpyrexia, and during the next eighteen days the patient experienced twelve additional severe chills. The temperature was of a very septic type, ranging from normal or slightly above normal in the mornings to 103° or 105° each afternoon. (Fig. 4.) A chest plate taken on the seventh post-operative day showed a slight elevation of the right leaf of the diaphragm, but the bases of both lungs were quite clear. Fluoroscopical examination of the chest twelve days after operation showed a normal excursion of both diaphragms and there was nothing as yet to suggest hepatic abscess or upper abdominal peritonitis. Abdominal examination showed a slight increase in the resistance of the upper abdomen, particularly on the right, and the liver was now two finger-breadths below the costal margin to percussion. Pain was not a feature, although there was moderate tenderness over the enlarged liver. The leucocytes ranged between 19,000 and 23,000 and the hæmoglobin had fallen from an initial reading of 80 per cent. to 65 per cent. There was no demonstrable jaundice at this time and bile salts did not appear in the urine until twenty-two days following the appendectomy.

Fluoroscopical examination of the chest eighteen days after operation showed a normal excursion of both diaphragms and no lesion in either base. A needle introduced into the left chest posteriorly in the eighth and ninth interspaces yielded nothing. By the same procedure repeated on the right side thirty cubic centimetres of turbid greenish yellow fluid were obtained by aspiration. Exploration of the right lobe of the liver revealed only dark blood in the aspirating needle. A culture of the fluid was negative. The patient continued to run a septic temperature, with a rapid pulse, leucocytosis

of 20,000 and appeared to be very ill. He undoubtedly had a pylephlebitis, probably with hepatic abscess.

Twenty-nine days after the first operation, a needle was again introduced into the lower right chest and thirty cubic centimetres of greenish yellow fluid obtained, similar in type to that found on aspiration at the same site eleven days previously. With a long exploring needle an attempt was again made to locate pus in the right lobe of the liver with no result. A slight degree of œdema of the chest-wall was now present over the right lobe of the liver, especially in the mid-axillary line. Fist percussion was moderately painful at this site. The sclera had a definitely icteroid tint, but there was no jaundice of the skin noted. A moderate degree of emaciation with anorexia and lassitude had become prominent features of the illness.

August 8, 1931, thirty-two days after his appendectomy, exploration of

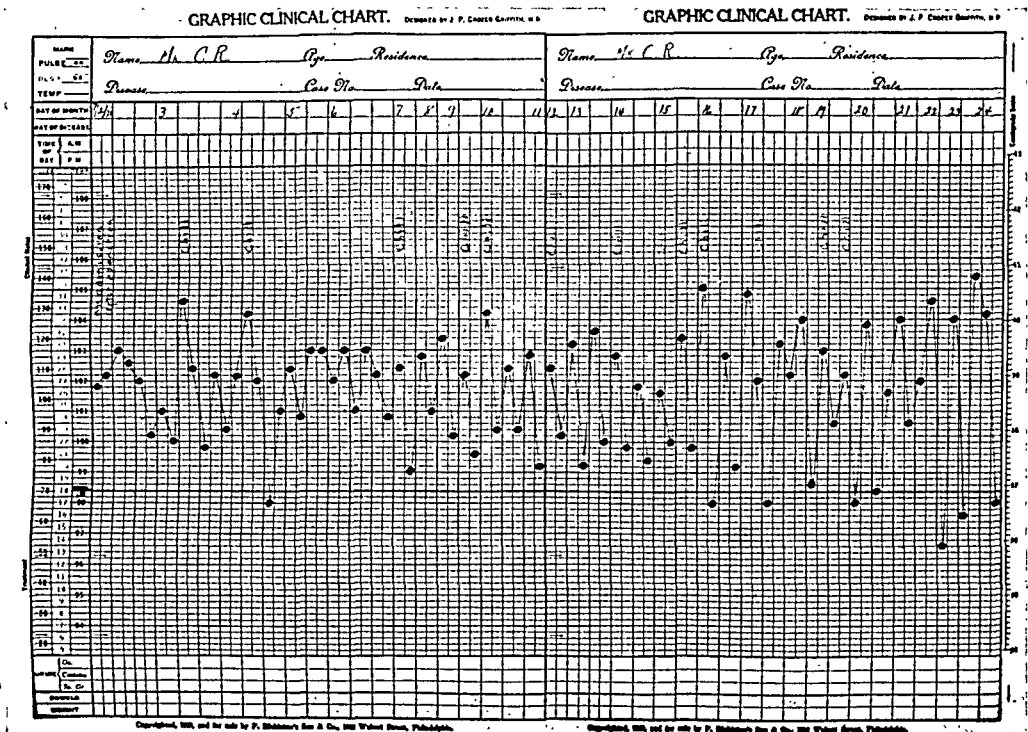


FIG. 4.—Temperature chart during the post-operative period demonstrating its "hectic" character.

the right upper quadrant of the abdomen revealed a moderate amount of yellow, slightly turbid, ascitic fluid in the peritoneal cavity. The liver was engorged, dark purple in color, and extended three finger-breadths below the costal margin. Exploration of the hepatic surface was negative for abscess. Careful palpation suggested the presence of several firm areas lying deep in the right lobe of the liver, considered to be inflammatory in nature. In the region of the common duct there was palpable a firm indurated cord passing down from the liver which represented the thrombosed portal vein. There was a great deal of œdema in this region which had completely obliterated the foramen of Winslow. The posterior peritoneum presented a glazed gray color, typical of œdema, but no thrombosed veins could be identified in the retroperitoneal tissues. The gall-bladder appeared normal. The right lobe of the liver was then explored with a long needle, especially in the suggestive indurated areas, but no purulent material could be obtained. The diagnosis

of pylephlebitis was definitely substantiated, but the presence of liver abscesses could not be proven. No operative procedure could be done that would materially benefit the patient so the abdomen was closed and the patient given 450 cubic centimetres of blood on the table.

Post-operatively the patient reacted quite well, although the temperature continued to be of the septic type, ranging from normal to 103° each day with a leucocytosis of 17,000 to 22,000. There was a rather severe degree of anæmia present at this time with a red blood-cell count of 3.5 million and a hæmoglobin of 58 per cent. Following this exploration, however, the patient ceased to have chills and none was observed during the remainder of his stay in the hospital. Transfusions were given at intervals of two weeks to maintain the red blood-cell and hæmoglobin levels. Two weeks following this exploration a mild left-sided femoral phlebitis developed, the major signs clearing up within seven days. The patient was permitted out of bed twenty-five days after the second operation, although the temperature was still of the septic type with a daily afternoon rise ranging between 101° and 103° . There were no subjective symptoms complained of except marked weakness and a moderate degree of abdominal distention which responded to enemas. Two months after the appendectomy a needle was again introduced into the seventh thoracic interspace on the left posteriorly and a liter of clear straw-colored fluid removed. A culture of this fluid was reported negative. Fluoroscopic examination now showed both diaphragms to be moderately fixed, moving but slightly with coughing.

During the next three weeks the patient's condition in general remained stationary. The temperature remained septic, although the excursion now swung between normal and 101° and the leucocytes had fallen to 13,000. September 25, 1931, one-half liter of fluid was again withdrawn from the left chest, its character identical with that previously removed. Following this second thoracentesis, there seemed little tendency for the fluid to reaccumulate. The patient left the hospital for a nursing home eighty-nine days after his operation for appendicitis. Examination two weeks after leaving the hospital showed the chest almost clear; there had been a weight gain of twelve pounds and a marked general improvement. The temperature was normal when seen and the leucocytes were 7,000. When last examined December 11, 1931, five and one-half months after his appendectomy, there had been a gain of twenty pounds in weight. There was no evidence of portal obstruction. An X-ray study of the chest showed that both domes of the diaphragm moved normally and the lung fields were quite clear. The red blood-cell count was five million, the white blood-cells numbered 6,500 and the hæmoglobin was 90 per cent.

Doctor Eliason added that pylephlebitis with or without hepatic abscess occurs following surgery for acute appendicitis in from .1 to .4 per cent. of all cases. In 1926, he reviewed this subject and found in the literature reports of fifty-three cases of pylephlebitis with liver abscess following appendicitis. Fourteen personal cases were reported, bringing the total number to sixty-seven, with a mortality of 54.4 per cent. Reports of twelve additional cases published since that time have been collected, which, with the case reported here, brings the total number to eighty with a 52.5 per cent. mortality.

A study of the twelve cases recently reported shows that pylephlebitis alone was the complicating factor in five cases, pylephlebitis with associated

hepatic abscess in two cases, and in the remaining five cases only liver abscess was recorded, with no note of an existing pylephlebitis.

The case now reported in some detail represents a case of proven pylephlebitis unassociated with hepatic abscess, recovering after a protracted illness of six months. The pre-operative history of a chill suggested that the infectious process had already extended upwards from the appendix, this being confirmed at operation by the presence of thrombosed appendiceal vessels. The subsequent history of the case was typical, demonstrating practically all of the features commonly associated with this condition. Boggy œdema, pitting with difficulty, was noted in the mid-axillary line opposite the tenth rib on the right in this case, offering further evidence that this is a diagnostic point of importance. Pain was not a marked feature, but icterus of mild degree, hepatic tenderness, nausea and vomiting, lassitude, anorexia and emaciation were all evident features. In this case, X-ray studies of the patient at frequent intervals were of great assistance in following the course of the illness. Great importance is now placed upon the roentgenological examination of the diaphragm and chest. In a recent paper Doctor Pancoast has described in detail the X-ray aspects of pylephlebitis and liver abscess. Although operation demonstrated the portal vein to be thrombosed, ascites of definite degree did not develop, confirming the observation formerly made that ascites rarely develops with pylephlebitis following appendicitis.

Liver abscesses could not be demonstrated in this patient, although the liver was thoroughly inspected at operation and explored with needles. The later development of a left-sided pleural effusion suggested that the left side of the liver might have been the affected side, yet the subsequent complete recovery of the patient leads one to believe that hepatic abscesses were never present. It has been observed that single abscesses occur in the right lobe of the liver in over half of the affected cases, and in these surgery offers relief, while multiple abscesses usually involve the left lobe or the entire liver, offering little from a surgical standpoint.

There has been considerable discussion concerning the correct method of handling pylephlebitis in those cases in which the diagnosis can be made at the time of the appendectomy. Incision or excision of the thrombosed ileocolic veins before performing the appendectomy has been advocated by Gerster, Wilius and Braun. Neuhof has suggested ligation of the portal vein, this having subsequently been done in four cases by Colp with a mortality of 75 per cent. The later author has abandoned this procedure and suggests that resection of the ileocolic veins at the time of the appendectomy would seem the more safe and rational procedure in those cases in which this is technically possible. Pylephlebitis having developed, surgery can be of help only in the advent of the development of a hepatic abscess so situated that it may be approached and drained. The frequency with which these abscesses appear as a large solitary collection of pus in the right lobe of the liver makes the transthoracic approach the method of choice. In those cases

CARCINOMA OF BOTH LEGS

in which drainage can be instituted, the results are very gratifying and these constitute approximately 47 per cent. of the reported cases developing hepatic abscess following appendectomy.

BIBLIOGRAPHY

- ¹ Colp, R.: The Treatment of Pylephlebitis of Appendicular Origin. Report of Three Cases of Ligation of the Portal Vein. *Surg., Gynec., and Obst.*, vol. xliii, p. 627, 1926.
- ² Barnes, W. A., and Pearson, L. V.: Suppurative Pylephlebitis and Hepatic Abscess. Case of Recovery. *British Med. Jour.*, vol. i, p. 390, 1928.
- ³ Eliason, E. L.: Pylephlebitis and Liver Abscess Following Appendicitis. *Surg., Gynec., and Obst.*, vol. xlii, p. 510, 1926.
- ⁴ George, W.: Appendicitis and Hepatic Abscess. *British Med. Jour.*, vol. i, p. 633, 1928.
- ⁵ Kramer, S. E., and Robinson, W. R.: Acquired Suppurative Diverticulitis with Pylephlebitis and Metastatic Suppuration in the Liver. *Surg., Gynec., and Obst.*, vol. xlii, p. 540, 1926.
- ⁶ Lindquist, Silas: Four Cases of Hepatic Abscess Following Appendicitis. *Acta Chir. Scandinav.*, vol. lxiv, p. 354, 1928.
- ⁷ Navarro, J. Carlos: Post-appendicular Abscess of the Liver. *Rev. Soc. Argent de Nipiol.*, vol. i, p. 153, 1925. *Abst. Jour. Am. Med. Assn.*, vol. lxxxvii, p. 450, 1926.
- ⁸ Nedelmann, E.: Symbiophiles Anaërobic Bacterium as a Cause of Pylephlebitis following Appendicitis. *Deutsches Arch. f. Klin. Med.*, vol. clx, p. 40, 1928.
- ⁹ Pancoast, H. K.: The Roentgenological Diagnosis of Liver Abscess with or without Subdiaphragmatic Abscess. *Amer. Jour. of Roentgenol.*, vol. xvi, p. 303, 1926.
- ¹⁰ Schlitz, C. F.: Pylephlebitis of Appendicular Origin. *Northwest Med.*, vol. xxix, p. 36, 1930.
- ¹¹ Wilmoth, C. L.: The Use of Exploring Needles and Shadow Casting Media in the Diagnosis of Hepatic Abscess and Peri-hepatic Abscess. *ANNALS OF SURGERY*, vol. xciii, p. 722, 1931.

CARCINOMA OF BOTH LEGS SUPERIMPOSED UPON CHRONIC OSTEOMYELITIS

DOCTOR ELIASON and DR. CHAS. McLAUGHLIN reported the case of a man, thirty-four, admitted to the Hospital of the University of Pennsylvania May 3, 1932, with large ulcerating lesions on the anterior surfaces of both legs. At the age of six he had suffered compound fractures of both tibiæ. Although union occurred, since that time draining sinuses had repeatedly appeared at the fracture sites, bits of bone being discharged from each at intervals of three or four months.

Six months before admission the patient received a blow on the anterior surface of the left tibia, following which spicules of bone were again discharged. The draining sinus did not heal as in the past, but persisted and increased in size, until a dirty, ulcerated area four inches in diameter was present at the site of the old injury. At the same time, a draining sinus on the anterior surface of the right tibia began to increase in size, presenting an area similar in appearance to that on the left leg, and measuring 2.5 inches in diameter. During the two weeks before admission the patient had suffered with pain in both legs, making walking difficult and interfering with his rest. There had been a weight loss of fifty pounds during the past six months. He was a large, well-developed and nourished man in spite of the history of recent weight loss. On the anterior surface of the left leg, beginning just below the tibial tubercle, was a huge ulcer, measuring eight by five inches in its two diameters. The surface was necrotic and there was an abundant thin purulent discharge with a foul odor. The granulation tissue, which was especially prominent about the edges of the ulcer, was pale and

œdematous. The margins were elevated and rolled, small dilated veins being evident in the elevated edges. A similar lesion was evident on the inner aspect of the middle third of the right leg, measuring five by three inches. Extensive scarring was present about both of the ulcerated areas, suggesting the appearance commonly seen in a chronic osteomyelitis of long duration. (Fig. 5.) Bilateral inguinal adenopathy was present, being more marked on the right. The glands were firm, freely movable and not tender.

X-ray examination of both legs showed marked deformity of the bones, the result of chronic osteomyelitis. An active infection could not be excluded from these plates, however, nor could a positive diagnosis of neoplastic involvement of the bones be made. (Fig. 6.) A chest ray was negative for evidence of metastasis.

Biopsy of both ulcers was performed May 4, 1932. These were reported

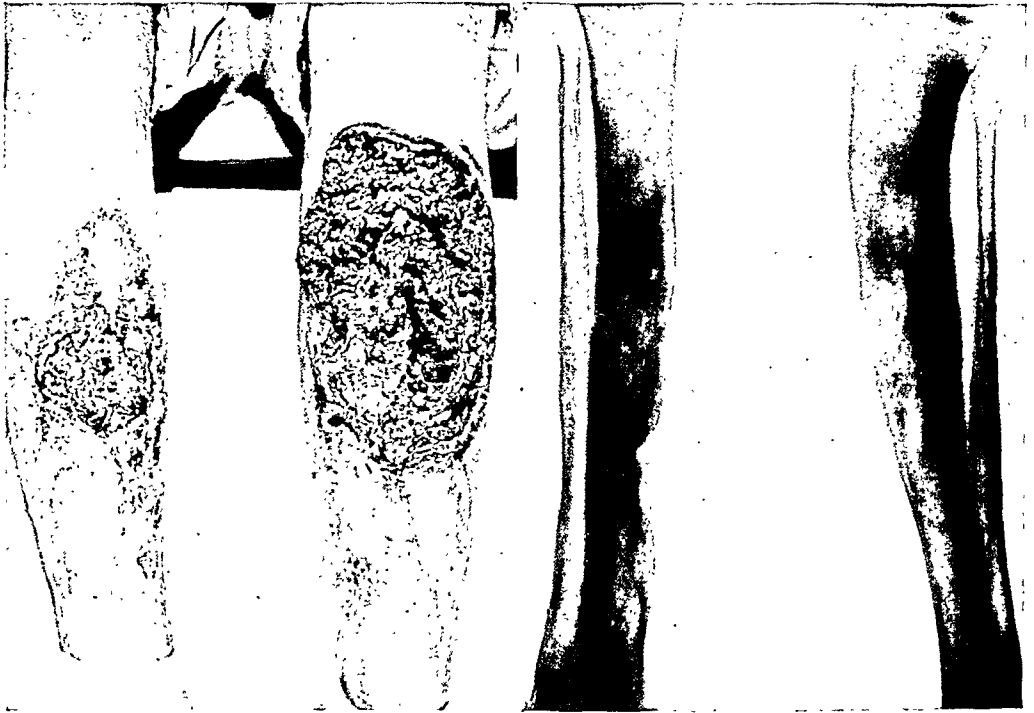


FIG. 5.

FIG. 6.

FIG. 5.—Appearance of the lesions on admission.

FIG. 6.—X-ray plate of tibia on admission. The appearance is typical of long-standing osteomyelitis. No definite diagnosis of neoplastic involvement of the bones could be made from these plates.

to show squamous-cell carcinoma, graded I, in the Broders classification. Because of the extent and nature of the lesions, amputation was decided upon and advised.

Under spinal anaesthesia, the left leg was amputated at the junction of the middle and lower third May 9, 1932. Examination of this specimen showed the tumor to be involving the bony tissue. (Fig. 7.) The stump healed by primary union. The ulcer on the right leg was meanwhile treated with dressings of balsam of Peru in an effort to decrease the odor incident to the foul discharge.

May 23, 1932, a disarticulation of the right knee-joint was done under spinal anaesthesia, the patient reacting well from this procedure. Examination of this limb after operation demonstrated that the tumor here was invading the bone also. Convalescence following this second operation was

CARCINOMA OF BOTH LEGS

interrupted by a wound infection which appeared on the eleventh post-operative day. A pocket of pus was found under the anterior skin flap. A hemolytic streptococcus was cultured from this. Subsequently the patient did well, the wound healing satisfactorily by granulation tissue. He was discharged June 21, 1932, the left stump being well healed and the right stump presenting a clean granulating area six centimetres in diameter. Six weeks later he was readmitted for a course of deep X-ray therapy to the inguinal regions. He had gained fifteen pounds and was free from all pain or discomfort. On this admission it was impossible to palpate any enlarged inguinal glands. During this period several skin grafts of the Reverdin type were placed upon a small granulating area still present on the right stump. He was discharged with his right stump becoming epithelized August 11, 1932.

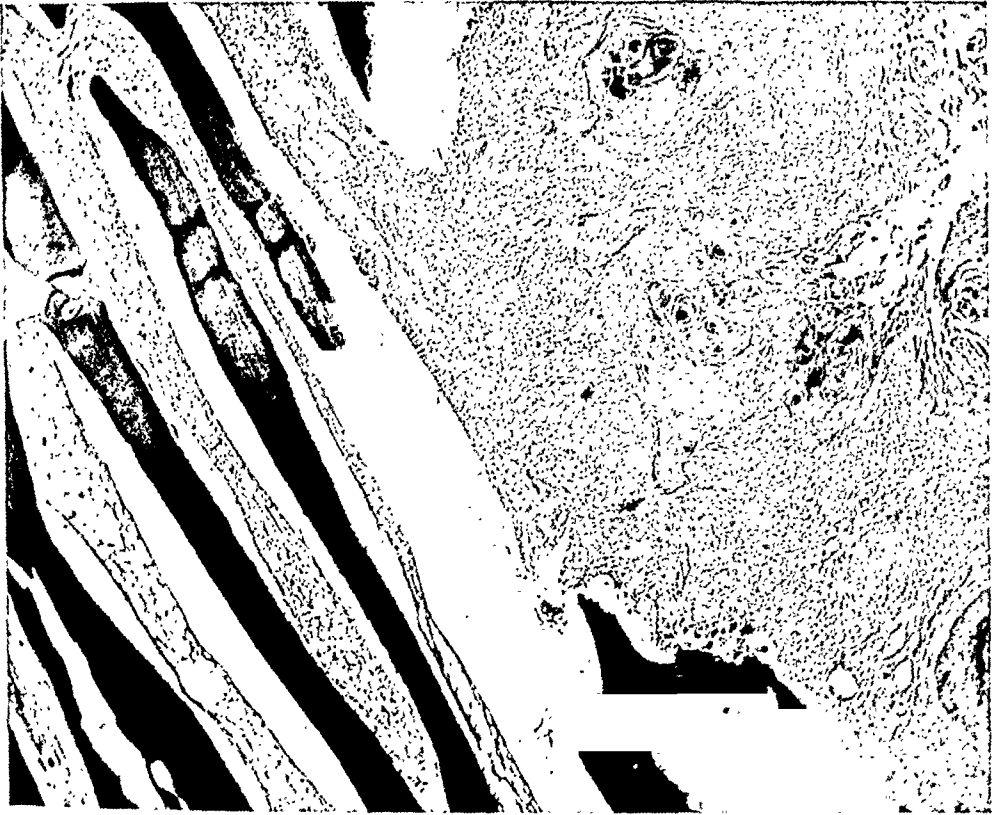


Fig. 7.—Photomicrograph of section of the tumor. Actual invasion of the bone is here evident.

A note from the patient October 3, 1932, stated that both stumps are well healed; he is entirely free from pain and feeling well.

DOCTOR McLAUGHLIN remarked that carcinoma arising in osteomyelitis has been recognized for many years, being first described by Hawkins in 1833. Bennett has recently reviewed the entire subject, reporting a series of ten cases from the records of the Massachusetts General Hospital. In a series of 2,400 cases of osteomyelitis, this author found twelve cases of malignant degeneration. All of the patients were middle-aged males with a history of long-standing draining sinuses. In 66 per cent. of the cases the lesion appeared engrafted upon an osteomyelitis of the tibia.

The history of the patient presented above is quite typical of the entire group. Pain, which is usually a prominent feature, was present here in a marked degree and there was a definite history of trauma prior to the development of the malignant ulcer. The unusual feature of this case is its bilateral character, both lesions appearing within a few weeks of each other. Such a case certainly speaks for the rôle played by long-standing chronic inflammation in the development of malignant disease.

PHILADELPHIA ACADEMY OF SURGERY

This form of tumor is usually slow-growing and the results following amputation have been quite satisfactory. In our case the fact that the glands present on the first admission were not palpable when the patient was readmitted six weeks later, suggests that this adenopathy may have been the result of the chronic inflammation and not of neoplastic involvement. The fact that malignant degeneration does occur in chronic draining osteomyelitic sinuses stresses the necessity of making every effort to heal all such sinuses whenever possible.

BILATERAL OSSIFIED HEMATOMA AT THE ELBOW

DOCTOR ELIASON reported the case of a woman, aged thirty-five, admitted to the Philadelphia General Hospital May 18, 1932, with a diagnosis of paresis. Four days before she became suddenly deranged. On admission to the hospital she was violent and had to be restrained for a matter of six weeks during her stay. During the first few days she had several venous punctures, all in the anti-cubital spaces; also intravenous typhoid antigen inoculations.

The patient was seen by the reporter June 16, 1932, just four weeks from the time of admission. Examination disclosed hard, firm swellings in both anti-cubital spaces. A diagnosis of ossified hematomata was made and confirmed by X-ray examination the following day. She was given physical therapy with resultant marked improvement in the left arm. The right arm did not respond at all, and on discharge from the hospital she had no motion in the elbow-joint whatever.

X-rays taken fourteen weeks after the onset showed entire disappearance of the shadow in the left arm, but the right arm disclosed an increased density of the previous shadow which is described by the röntgenologist as being a marked increase in the ossifying process resulting in ankylosis of the elbow-joint. In this case there was no fracture or dislocation associated with it; it is bilateral, which is very unusual, and one elbow has completely recovered but the other has gone on to complete ankylosis.

DR. BENJAMIN LIPSHUTZ remarked that the general thought on myositis ossificans is that it rarely occurs in women. Those seen by the speaker have all been in males. Another point worthy of emphasis is the keeping away from any active movement in these cases. Massage and use of heat only increase calcification. Therapeutically puncture of the initial hematoma does not inhibit the subsequent calcification. The history of many cases followed is that some progress satisfactorily to recovery; in others the calcification remains stationary. The calcium in the muscle tissue is not true bone. A very careful study of calcium as related to bone development and as related to different pathological processes has shown that in bone development calcium is largely the result of secretory activity of the osteoblasts and in myositis ossificans it is due to the precipitation of calcium salts in the tissues.

DOCTOR ELIASON rejoined that the pathologist reported true bone with Haversian's systems in a specimen that he removed. One other writer has mentioned this fact and previous to his observation this lesion was spoken of as a calcified hematoma. Latterly it has usually been designated as an ossified hematoma.

EXTERNAL GASTRIC FISTULA

DR. NORMAN S. ROTHSCHILD reported the case history of a man, aged twenty-nine years, admitted to the accident ward of the Graduate Hospital

at 5 A.M., May 15, 1931, with the history of having eaten some doughnuts at 3 A.M. At 4:30 A.M. he was seized with sudden severe pain in the epigastric and right hypochondriac regions, but did not vomit. His temperature was 95.2° , pulse 72 and respiration 20. The anterior abdominal wall above the level of the umbilicus had a board-like rigidity. His skin was cold and covered with perspiration, the pupils were equal and reacted to light and accommodation. Otherwise the physical examination was negative. It was elicited that about a year previous he had an attack of indigestion which lasted two or three weeks and consisted of epigastric pain, acid regurgitation, belching, but no vomiting. This pain was increased by the taking of food and relieved by bicarbonate of soda. One week before admission the pain returned but had no relationship to the taking of food and was relieved by "Caroid." He had not been constipated nor was he conscious of having had bloody or tarry stools. There was no history of jaundice.

He was operated upon two hours after admission to the hospital. An upper right rectus incision into the peritoneal cavity disclosed an oedematous pylorus with a perforation on the anterior surface of the stomach about one inch proximal to the pylorus. Considerable gastric contents were found in the peritoneal cavity. Three mattress sutures of fine chromic catgut were used to close the perforation, but it was impossible to cover the wound with serosa because of the oedema of the tissues; a portion of the great omentum was therefore amputated and sutured over the site of the perforation. Suprapubic drainage was finally established.

During the first twenty-four post-operative hours his temperature gradually rose to 102.2° and the respirations to 48, with considerable respiratory embarrassment. After the giving of 10 per cent. carbon dioxide and 90 per cent. oxygen for a period of fifteen minutes every two hours a productive cough was established which resulted in the expectoration of a moderately thick sputum, and upon the establishment of this expectoration the patient's condition improved. On the fourth post-operative day, although the physical signs showed marked re-aëration of the involved lobes of the lungs, pneumonia developed in the base of the right lung. The temperature remained around 101° , but the pulse and respirations became slower. The abdominal wall was soft and there was a slight serous discharge from the suprapubic drain. His general condition was satisfactory.

May 24, the tenth post-operative day, the dressings became soaked with a sour-smelling, faintly yellow-colored fluid. This was found to be acid in reaction and it caused a mild irritation of the skin adjacent to the wound. An attempt was made to pass an Einhorn tube through the pylorus into the duodenum, but this failed, the tube not passing beyond the site of the perforation, and although it was attempted under the fluoroscope, no success was obtained until a beaded shot was passed into the duodenum to which a silk thread was attached. The other end of this silk thread was fixed to the end of the Einhorn tube and in this way the jejunum was entered. The position of this tube was verified by X-ray examination. The patient was fed every two hours from 8 A.M. to 8 P.M., his feedings consisting of eight ounces of orange juice, milk or broth. After each milk feeding eight ounces of saline was given.

On the fourth day following the insertion of the tube the drainage from the fistula had ceased. The tube was allowed to remain in the jejunum for sixteen days, when he was discharged from the hospital to receive further care in the gastro-intestinal clinic.

During the summer he had a return of the pain and for this he was admitted to the Philadelphia General Hospital, in Doctor Owen's service,

September 8, 1931. Two days later, under spinal anæsthesia, an upper right rectus incision was made into the peritoneal cavity. A few adhesions were noticed around the pylorus and a distinct fibrous tract running from the site of the ulcer on the pre-pyloric portion of the stomach to the anterior abdominal wall. A posterior gastroenterostomy was made and the fistulous tract was dissected from the abdominal wall and the anterior wall of the stomach by means of the actual cautery. The raw surface was covered by serosa. Uneventful recovery followed this operation and he was discharged from the hospital September 26. He reported for active duty November 12, 1931, and has been symptom-free since.

THE TREATMENT OF INTERCOSTAL NEURALGIA OF THE ABDOMINAL WALL

DR. J. B. CARNETT and DR. WILLIAM BATES read a paper with the above title.

DR. S. DANA WEEDEER called attention to causes remote from the abdominal cavity which may cause abdominal pain.

Mackenzie has described what he believes to be the mechanism of the reflex which causes hyperalgesia of the skin and contraction of the intercostal muscles of the pre-cordial area and referred points in heart disease. In brief, he states that abnormal conditions in a hollow viscus with a muscular coat set up a stream of nervous energy through the sympathetic nerves which cause an irritable focus in a segment of the cord which spreads over the sensory fibres going to the brain which are interpreted by the brain as pain or hyperalgesia of the skin at the peripheral distribution of the nerve which is usually over the affected viscus and if spread over the motor area to cause spasm of the muscles of the parieties overlying the affected viscus.

These reflex phenomena furnish us with most valuable diagnostic aids—localized pain, tenderness and rigidity—over an affected viscus. He also points out, which has been demonstrated by all surgeons, that a viscus may be handled without pain but pinching, twisting, pulling, distention or hyperperistaltic waves will cause pain.

It is possible, therefore, that deep pressure may be exerted upon a diseased viscus, the mixed nerves of the parietal wall having been paralyzed by novocaine injection, without giving pain or increased resistance and an erroneous conclusion then being drawn that there is no disease of the underlying viscus.

This reflex the speaker believes accounts for the pain, tenderness and increased muscular resistance of the upper right abdomen in gall-bladder disease; of the lower right abdomen in appendicitis and the backache in a large percentage of pelvic conditions. It certainly seems impossible for direct pressure by a displaced uterus, small tumors, cysts or some cases of salpingitis to exert pressure upon the sacral plexus which in most instances cannot be demonstrated at operation or autopsy. The same reflex as before described must again be the true explanation of the backache suffered so commonly by these patients.

TREATMENT OF INTERCOSTAL NEURALGIA

DR. HUBLEY OWEN said that from personal observation at the Philadelphia General Hospital during the past few years he had observed the effect of Doctor Carnett's teaching on the question of intercostal neuralgia. He believed that his theory is being overemphasized to a dangerous degree. Undoubtedly we can have neuralgia of the intercostal nerves with referred pain and hypersensitiveness of the abdominal wall but the minds of the internes as well as medical students have been confused by the overemphasis of this condition.

The speaker had had three cases at the Philadelphia General Hospital diagnosed as intercostal neuralgia, two of which were cases of very acute appendicitis and one of calculus cholecystitis. The mortality of appendicitis is too high. Delay in operation for appendicitis is the cause of the high mortality. Do not let us make further confusion in the minds of the internes and students by any overemphasis of intercostal neuralgia.

DR. BENJAMIN LIPSHUTZ said that the use of the label intercostal neuralgia for such a wide range of disturbances seems too inclusive. It is much like the term chronic abdomen that was used many years ago by Hutchinson. All symptoms wherever possible should be interpreted on basis of known anatomical and physiological data. Every sensory impulse, including pain, has its cell body in the posterior root ganglion.

The nerve supply of the abdominal wall and of the parietal peritoneum is segmental with varying degree of nerve overlap. Similar segments of the abdominal wall and of the parietal peritoneum are supplied by the same sensory fibres. True visceral pain, on the other hand, is felt deep in the abdomen, cannot be accurately localized, and is mediated probably by means of separate pathway, which extends only to the thalamus, thus accounting for the vague localization that occurs with true visceral pain. The visceral organs are governed only by the diencephalon. Admittedly the exact course of the visceral or sympathetic afferents are not accurately known. Recently Kuntz has demonstrated the presence of visceral or sympathetic afferents in the gray rami of the lumbar nerves. It would appear, therefore, that many cases included under caption of intercostal neuralgia unless clearly segmental must be classified more accurately.

DR. HENRY P. BROWN, JR., believed that it is unsafe to place too much stress on the diagnosis of intercostal neuralgia in the presence of acute or subacute abdominal symptoms, especially when these symptoms and signs indicate appendicitis. In view of the fact that in Philadelphia the yearly mortality from appendicitis is increasing in spite of propaganda directed toward both the profession and laity, and apparently the only way to reduce this mortality is by early diagnosis and removal of an appendix which is causing symptoms, be they mild or severe, it seems that should Doctor Carnett's views in this matter be generally accepted, many cases of appendicitis will be overlooked in the stage when appendectomy should be a compara-

tively minor operation, and will only receive surgical relief in that stage when the mortality figures are unfortunately so high.

It would appear that it is better to occasionally remove a doubtful appendix in the presence of intercostal neuralgia than to subject the patient to the risk of perforation and its sequelæ through failure to recognize an appendix, which though the symptoms may be mild at the outset, is such a potent fact for serious consequences.

DR. WALTER G. ELMER remarked that pain referred from the spinal column to the anterior portion of the thorax and abdomen has long been stressed in teaching students in order to avoid mistakes in diagnosis. The spine may be diseased and this may reflect the pain to the termination of the nerve trunks. The spine may be out of line and the unnatural strain thrown upon ligaments and muscles may be reflected along the nerve trunks to some distant region. It requires a very severe deformity of the spinal column or an injury to the spine to cause compression of the nerve trunk in the intervertebral foramen as the diameter of the foramen is much greater than that of the nerve trunk. It is about equivalent to passing a lead pencil through a finger ring. Infectious processes about the articulations of the spine, such as gonorrhœa, for example, may cause the deposit of inflammatory exudate, fibrous connective tissue, exostoses and periosteal thickening which may so encroach upon and imbed the nerve trunks that referred pain will result. Not only is pain referred along the nerve trunk to its distant branches but the nerve and its branches may become exceedingly hypersensitive and tender. This is then both a neuritis and a neuralgia and the clinical picture may be described as radiculalgia. This condition has of course long been recognized. The undoubted value of the studies of Doctor Carnett and Doctor Bates in this field lies in the fact that mistakes have frequently been made in diagnosing the cause of abdominal pain. They demonstrate very clearly how easily intercostal neuralgia may be mistaken for intra-abdominal inflammation or disease and they point out very clearly how these mistakes can be and should be avoided.

DR. J. B. CARNETT remarked that Doctor Weeder is an advocate of the Mackenzie viscerosensory theory which the former unqualifiedly and wholeheartedly condemned as being absolutely erroneous and misleading. The Mackenzie theory is promulgated mainly by the medical men. The vast majority of thoughtful surgeons have had ample opportunities at operation on abdominal lesions to determine the fallacies of the viscerosensory theory and do not believe in it as applied to the abdominal viscera. Unfortunately, operations on the thoracic viscera are not available to demonstrate its inaccuracy as applied to them. However, he has had many opportunities of examining patients in the midst of acute pain attacks of acute coronary thrombosis and of angina pectoris without evidence of coronary disease and in the absence of a coincident neuralgia has found the acutely painful areas entirely free from tenderness by the most vigorous possible pinching, by

TREATMENT OF INTERCOSTAL NEURALGIA

pin pricking or stroking, and by firm poking palpation. He has seen a sufficient number of cases now to be convinced that any tenderness found during an angina attack is due to an associated neuralgia which is in no way dependent on a cardiac or aortic lesion. In other words, the presence of superficial tenderness neither proves nor disproves the existence of a cardiac or aortic lesion nor of an abdominal visceral lesion. Parietal neuralgia may exist alone or in association with any chest or abdominal lesion but the tenderness of neuralgia should never be mistaken for visceral tenderness either directly or indirectly on the basis of Mackenzie's viscerosensory theory. He further did not agree with Doctor Weeder's assumption that muscular rigidity and superficial tenderness are due to an identical mechanism. Either of these two symptoms may be found in the absence of the other in numerous patients.

He has found by abundant experience that novocaine injections of the abdominal wall or parietal nerve trunks do not abolish visceral tenderness. They do abolish the parietal pain and tenderness of neuralgia and permit proper evaluation of symptoms or lack of symptoms indicative of visceral disease. The frequent failures to overcome the backache and widespread pain and tenderness by operative correction of the pelvic lesions to which Doctor Weeder refers indicate that these symptoms were due to other causes, probably postural spinal stresses and the neuralgias so commonly accompanying them.

He strongly disapproved of needless operations which Doctor Owen and Doctor Brown evidently regard as of minor importance. The judgment of internes as to the necessity for or against operation is not a proper criterion by which to determine the value of new methods of diagnosis with which their own chiefs may not be familiar. He recalled having examined two patients with supposed acute appendicitis with Doctor Owen and demonstrated one had it and the other did not as Doctor Owen found at operation upon them before his class but the latter frankly stated his inability to explain how the correct pre-operative diagnoses had been made. A better understanding of neuralgia would have obviated the needless removal of that innocent appendix.

He agreed with Doctor Lipshutz that true visceral pain is felt deep in the abdomen but he further issued the warning that the majority of neuralgia patients when asked if their pains are superficial or deep will reply that they are deep seated.

It is true as Doctor Owen and Doctor Brown suggest that internes and general practitioners may withhold operation in urgent cases of acute appendicitis on the assumption that all the symptoms are due to neuralgia. They do the same thing on a mistaken diagnosis of acute pelvic inflammatory disease for which operation is contra-indicated but that does not constitute a reason for condemning a diagnosis of salpingitis because it might increase the mortality rate in acute appendicitis. The obvious need is better training both in salpingitis and parietal neuralgia. Lacking that the inexperienced should refer all doubtful cases to the surgeon for decision and the latter

should feel the same chagrin for a needless appendectomy in parietal neuralgia as in acute salpingitis. The acute neuralgias which simulate acute appendicitis occur most commonly in the later stages of a respiratory-tract infection when a general anæsthetic is not entirely free from danger.

Unfortunately, the needless operations brought about by the failure to recognize parietal neuralgias are not restricted to the occasional appendectomies to which Doctor Brown refers. It is not uncommon to see patients who have had three or more—up to a dozen—operations of varying grades of severity, some of which were attended with grave mortality risks and who continue to have their original pain and tenderness caused by parietal neuralgia.

POST-OPERATIVE URINARY RETENTION

DR. CLAUS JORDAN, by invitation, read a paper with the above title for which see *ANNALS OF SURGERY*, vol. xcvi, July, 1933.

BRIEF COMMUNICATION

X-RAY DIAGNOSIS OF COMMON DUCT STONES

THE difficulty in visualizing common duct stones by X-ray, even with lipiodol, is well known. The two case reports by Ginzburg in the *ANNALS OF SURGERY* September, 1932 (vol. xcvi, p. 474) have prompted us to report a case which not only showed two stones with lipiodol injection, but actually on the flat plate before injection. (Fig. 1.) This case emphasizes the advisability of a careful exploration of the common duct when the preoperative X-ray findings suggest the possibility of stone, even when there is no history of jaundice. Had the common duct been more carefully explored, the second operation would probably not have been necessary.



FIG. 1.—Arrows indicate two common duct stones on flat plate.

Miss P. V., aged thirty-five, entered the hospital August 15, 1931, complaining of colicky pain in the right upper quadrant in attacks associated with epigastric fulness for five months, never with jaundice. Her last attack began six days prior to admission with sudden sharp cramping epigastric pain which persisted for several hours, associated with gas, nausea and vomiting and relieved only by opiates. The attack gradually subsided but tenderness over the right upper quadrant persisted.

A flat plate of the abdomen (Fig. 1), August 15, 1931, showed a "gall-bladder partially outlined with numerous small stones in the gall-bladder. There were two stones in the cystic duct and one shadow in the region of the common duct." August 18, 1931, a cholecystectomy was performed. In view of the X-ray report, a probe was passed through the open cystic duct, but no stone was felt in the common duct.

Post-operatively, the patient became moderately jaundiced and poured bile from the wound constantly. The stools were bile-free. Three weeks after operation, lipiodol was

BRIEF COMMUNICATION

injected into the sinus tract and two common duct stones were seen by X-ray. "The hepatic and common ducts filled readily down to the first stone and after fifteen minutes a small amount of lipiodol passed the first stone, down to the second stone. None reached the duodenum."

Second Operation.—October 15, 1931, through the former wound the common duct was exposed and opened. The first stone was readily removed through the incision in the common duct but the second was impacted at the ampulla of Vater and necessitated a transduodenal approach. The stone was pushed back up the duct and removed. Two stones were also removed with a scoop from the hepatic duct. A transfusion of 500 cubic centimetres was performed during the operation. The abdomen and common duct were drained.

LON GROVE, M.D.

JOSEPH C. READ, M.D.

Atlanta, Georgia

MEMOIR

GEORGE HOWARD MONKS, M.D.

1853-1933

IN THE death of Dr. George Howard Monks January 6, 1933, the surgical profession of our country and his native New England lost a man whose place, both as a man and a surgeon, it will be hard to fill. Primarily he was



GEORGE HOWARD MONKS, M.D.

an artist, and everything he did in his profession was marked by an artistic skill peculiarly his own. He had spent many laborious years in teaching in the Harvard Medical School, especially in the Department of Surgical Anatomy in which he always showed a special interest. He had done much

work in plastic surgery and contributed a great deal to that subject. He wrote on operations for correcting deformity due to prominent ears, unilateral laryngectomy for carcinoma, spiral fractures of the humerus, flushing of the intestinal canal through multiple enterostomy openings, plastic operations on the nose by Tagliacozzi's method, and many other subjects. His work on intestinal localization, which he perfected by long study on the cadaver, was one of his most important contributions. In this he demonstrated that a coil of the small intestine presenting through any small incision in the abdomen could be closely localized by its physical characteristics so that its availability for low or high enterostomy could be determined without the formidable process of exenteration and going over the whole length of the bowel to see what part of the bowel presented. He also demonstrated that the entire small intestine could be strung on a straight rod or tube, a discovery which Lord Moynihan afterwards employed in devising his long straight tube for emptying distended coils of intestine in obstruction. This was the subject of the Mütter Lecture before the College of Physicians of Philadelphia in 1905. He published in all fifty-six papers, including biographical sketches of contemporary surgeons. One of the best was entitled *Selections from the Medical Writings and Sayings of Doctor Oliver Wendell Holmes*.

Doctor Monks was born in Boston, March 28, 1853, son of John P. and Delia S. (Hatton) Monks. He prepared for college at Boston Latin School. He was graduated from Harvard College in 1875 and entered the architectural department of Massachusetts Institute of Technology, where he studied during the following year. He then decided to study medicine and entered the Harvard Medical School, from which he was graduated in 1880. After a year of surgical internship at the Massachusetts General Hospital, Doctor Monks studied further for four years at Vienna, Leipzig, Heidelberg, Dresden, Paris and other continental medical centres. At the end of this period he passed examinations admitting him as a member of the Royal College of Surgeons of England.

He began the practice of surgery in Boston in 1884, and was appointed district physician of the Boston Dispensary and, later, visiting surgeon to the Carney Hospital. In 1890, he entered the Boston City Hospital and was promoted through various grades to surgeon-in-chief in 1910. He resigned in 1914 and was appointed consulting surgeon.

From 1886 to 1914 Doctor Monks was connected with the Harvard Medical School, resigning after lecturing on surgery at the school for eleven years. From 1886 to 1926 he was connected with the Harvard Dental School, and in those forty years he provided a valuable link between the Medical and Dental Schools. When he resigned he was Professor of Oral Surgery. He was appointed a professor emeritus.

He was at various times chairman and secretary of the surgical section of the Suffolk District Medical Society, president of the Suffolk District Medical Society, president of the Boylston Medical Society, vice-president

of the American Surgical Association, fellow of the American Medical Association, fellow of the American College of Surgeons, first president and co-founder of the Boston Surgical Society, senior member of the New England Surgical Society, president of the Boston Medical Library, Boston Society of Medical Sciences, American Medical Association, Massachusetts Medical Society, and the Boston Society for Medical Improvement.

During the recent war, being over age for active service, he was a member of the volunteer medical service corps and division medical adviser for the Red Cross.

It will be noted in the above account that he spent four years studying in European medical centres. In the autumn of 1883, while visiting his brother Robert in France, and preparing for the examination of the Royal College of Surgeons, he invented the game called "Halma," which was successfully introduced in this country by Dr. Thomas Hill of Portland, Maine, and later was manufactured and sold extensively in this and many foreign countries.

I cannot forbear introducing at this time a brief account of his avocations, taken from a sketch of his life which he himself wrote:

"I have had a number of 'hobbies,' to which I have given a good deal of attention, especially after retiring from active professional work. Perhaps the principal of these was sculpture, in connection with which I have modeled a number of subjects. It is pleasant to remember that my contribution to the Art Exhibition, held at the Tavern Club in 1886 for non-professional members (a small female head which I had modeled in red wax), received the first prize—'Le Grand Prix,' as it was called. Other pieces of amateur work were a bust of Mr. George Augustus Peabody (which was subsequently enlarged by Mr. John Wilson, and then put into marble, for the Peabody Museum at Salem, and another marble bust—a replica—for the Peabody Institute at Danvers); and also a small bust of Mr. George A. Gardner. My largest and perhaps most important work in the line of sculpture was a dancing figure, in bronze, for our little fountain at 'Briarwood.' I have also made a number of book-ends: among them a pair (in bronze) for Holmes Hall at the Boston Medical Library, after designs selected by the Librarian, Mr. James Ballard, from medical incunabula; another pair (in plaster) representing a man and a woman—for my friend—the late Dr. Morton Prince, and a replica of these for my wife; still another pair (in green bronze), being an attempt to make portraits of our two dogs, 'Zip' and 'Carina'."

On hospital and teaching staffs Doctor Monks was an ideal colleague—modest, kindly, and ever appreciative of the work of his younger associates, to many of whom he gave unstinted help. He was one of the most unselfish men that have ever lived. Every instinct was that of a gentleman, and, I may add, of an artist, and his own profit or advantage was the last thing of which he thought. In personal appearance he was strikingly handsome, nor did his appearance belie his character. As he grew older and gradually

retired from professional work he continued his artistic activities, and found in them joy and satisfaction, until nearly the end of his peaceful and fruitful life.

He was the founder of the Boston Surgical Society, and his influence induced the late Dr. Sturgis Bigelow to endow the Bigelow Medal, which has been presented to many distinguished surgeons in this country and abroad, for contributions to the art and science of surgery. He was greatly interested in and made many contributions to the Boston Medical Library.

He was married to Miss Olga E. Gardner in 1897. He leaves his wife, and three children: the Rev. George Gardner Monks, headmaster at the Lenox School; Dr. John Peabody Monks, a physician in Boston, and Miss Olga Monks. He also leaves a sister, Mrs. Walther Hempel of Dresden, Germany.

Such is a brief outline of the career of an eminent surgeon, and consummate artist. Rare indeed was the spirit of the man, and altogether lovely. To those who knew him intimately his memory will ever be a bright spot among the chequered experiences of their lives. Words fail in any attempt to depict his character. The writer can only regret that the only way to really appreciate him was to know him, and be thankful for his own delightful association with him for so many years.

FRED B. LUND

EDITORIAL ADDRESS

The office of the Editor of the *Annals of Surgery* is located at 386 Park Street, Upper Montclair, New Jersey. All contributions for publication, Books for Review, and Exchanges should be sent to this address.

Remittances for Subscriptions and Advertising and all business communications should be addressed to the

ANNALS OF SURGERY
227-231 South Sixth Street
Philadelphia, Penna.

INDEX FOR VOLUME XCVII

A

ABBOTT, WALTER D.: Surgical Aspects of the Autonomic Nervous System, 494.
 Abdominal Crises, Acute, Continuous Intravenous Infusions in, 749-787.
 Abdominal Pain, Causes of, 952.
 Abdominal Wall, Intercostal Neuralgia of, 952.
 Abscess of the Stomach, Intramural, 304; Paræsoophageal, 298; Splenic, 301.
 Adhesions, Arm-Chest, Their Plastic Reconstruction, 683.
 Adrenal Origin of Liver Tumor, 150.
 Adrenal Tumor and Precocious Sexual Development, 153.
 ALLEN, SAMUEL S.: Cysticercus of the Brain, 1.
 ALPERS, J.: Chondroma of the Intervertebral Disks, 10.
 Amputation, Interscapulo-Thoracic, 381; Krukenberg, 277.
 Anæmia, Sick-cell, Splenectomy for, 146.
 Anæsthesia, Avertin, 577; Spinal, Tropacocaine in, 757.
 Angiomas of the Breast, Subcutaneous, 401.
 Ankle-Joint Fractures, Treatment of, 130.
 Ankle, Unreduced Pott's Fracture of, Treatment of Mal-union, 394.
 Appendectomy Followed by Tetanus, 934.
 Appendicitis with Liver and Pleural Abscesses, 633; with Thombosis of Mesenteric Veins, 925.
 Arm-Chest Adhesions, Their Plastic Reconstruction, 683.
 ASHHURST, ASTLEY PASTON COOPER: Memoir of, 474.
 AUCHINCLOSS, HUGH: Jejunostomy, 625; Jejunostomy for Gastric Ulcer, 620.
 Autonomic Nervous System, Surgical Aspects of the, 494.
 Avertin Anæsthesia, 577.
 Axilla, Plastic Operations on, 941.

B

BACKMANN, R. F.: Torsion of the Omentum, 766.

BARBER, WILLIAM HOWARD: Jejunostomy, 625; Jejunostomy, Technic of, 553; Transplantation of Biliary Fistula into Stomach, 605.
 BANCROFT, FREDERIC W.: Management of Post-pyloric Ulcer, 123-126; Phlebitis Complicated by General Septic Invasion, 939.
 Bandaging, Principle of the Loop in, 798.
 BARNARD, LEONARD: Primary Hæmangioma of the Spine, 19.
 BARROW, DAVID: Memoir of, 476.
 BATES, WM.: Intercostal Neuralgia of Abdominal Wall, 952.
 BEEKMAN, FENWICK: Operations for Varicose Ulcers, 631; Wound Healing, 635.
 BEER, EDWIN: Megalo-ureter with Hydro-nephrosis, 141; Post-operative Intestinal Obstruction, 618; X-ray Therapy of Pituitary Body after Splenectomy for Purpura, 290.
 BERRY, FRANK B.: Torsion of Omentum, 785; Tuberculous Chondritis, 921.
 BIERMAN, WILLIAM: Irradiated Petrolatum, 930.
 Bile-duct, Injured Common, Repair of, 121, 930.
 Biliary Fistula, Transplantation of, into Stomach, 605.
 Birth-Fracture Deformity, Spontaneous Correction of, 639.
 BISGARD, J. DEWEY: Longitudinal Bone Growth, 374.
 Bladder Injuries, 154.
 Bladder, Involved in Hernia, 937; Support of, by Stump of Uterus after Partial Hysterectomy for Vaginal Prolapse, 74.
 Blood, Effect of, in Experimental Peritonitis, 414-470.
 BLOODGOOD, JOSEPH C.: Subcutaneous Angiomas of the Breast, 409.
 BOHRER, JOHN V.: Fractures of the Head and Neck of the Radius, 204.
 Bone Grafts, Dead, to Repair Skull Defects, 321.
 Bone Growth, Longitudinal, 374.

INDEX

- Bone, Wolff's Law as to the Internal Structure of, 318.
- Bones, Long, Sarcoma of the, Treatment of, 434.
- BOTHE, A. E.: Splenectomy for Sick-cell Anæmia, 146, 150.
- BOTHE, FREDERICK A.: Lumbar Sympathectomy in Buerger's Disease, 61.
- Bowel, Obstructed by Mesenteric Cyst, 639.
- Brain, Cysticercus of the, 1.
- Breast, Carcinoma of the, Irradiation in, 62; Operations for Cancer of, Skin Conservation after, 844; Subcutaneous Angiomas of the, 401.
- BRENIZER, ADDISON G.: Amount of Gland to Be Left after Thyroidectomy, 831.
- BROMER, RALPH: Congenital Duodenal Adhesions, 792; Sick-cell Anæmia, 149.
- Bronchoscopical Observations in Post-operative Pulmonary Complication—Jackson, 516.
- BROWN, HENRY P., JR.: Intercostal Neuralgia of Abdominal Wall, 953.
- Buerger's Disease, Lumbar Sympathectomy in, 471.
- Burns, Extensive Cutaneous, Study in, 670; Old, Unhealed, Treatment of, 648-786; Tannic Acid Treatment of, 641-786.
- Bursitis, Multiple Traumatic, 471.
- BUTTLES, E. M.: Carcinoma of Rectum in Thirteen-Year-Old Girl, 903.
- BUZBY, B. FRANKLIN: Recurring External Dislocations of Patella, 387-470.
- C**
- CALDWELL, JOHN A.: Treatment of Fractures in the Cincinnati General Hospital, 161.
- Cancer of Stomach, Ultimate Prognosis after Resection, 882.
- CARABBA, VICTOR: Principle of the Loop in Bandaging, 798.
- Carcinoma, of Both Legs Superimposed on Chronic Osteomyelitis, 947-949; of Breast, Irradiation in, 62; of Rectum in Thirteen-Year-Old Girl, 903; of Testis, Embryonal, 615; of Transverse Mesocolon Cyst, 782.
- Cardiorrhaphy, in Wounds of the Heart, 547.
- CARLSON, HJALMAR E.: Mesenteric Cyst Obstructing Bowel, 639.
- CARLUCCI, GASTON A.: Avulsion of Skin about Elbows, 634; Mal-union of Fore-arm Fracture, 635; Recurrent Diverticulum of Œsophagus, 299.
- CARNETT, J. B.: Intercostal Neuralgia of Abdominal Wall, 952-954.
- Carpal-Scaphoid Fractures, End-Results of, 209.
- CARTER, R. FRANKLIN: Muscle Pack to Control Hæmorrhage from the Liver, 636; Muscle Pack to Control Liver Bleeding, 636.
- CAVE, HENRY W.: Management of Post-pyloric Ulcers, 123; Tumors of the Small Intestine, 144.
- CAYLOR, HAROLD D.: Multiple Myeloma Simulating Hyperparathyroidism, 823.
- Chest, Penetrating Wounds of the, 528.
- Chest Wall, Localized Tuberculosis of, 247.
- Cholecystectomy for Nitrahepatic Gall-Bladder, 296.
- Chondritis, Costal, 920.
- Chondroma of the Intervertebral Disks, 10.
- Chorionepithelioma, Ectopic, 910.
- Cincinnati General Hospital, Treatment of Fractures in the, 161.
- Clamp, Inter-ringed, 794.
- Claudication, Intermittent without Gangrene, Controlled by Sympathetic Nerve Block, 503.
- COHEN, IRA: Osteomyelitis of Skull, 733.
- Colectomy, Partial, Blind Pouch Development after, 116.
- COLEY, BRADLEY L.: Embryonal Carcinoma of Testis, 615; Knee-Joint Dislocation, 129; Phlebitis, Acute, with General Septic Invasion, 939; Retroperitoneal Hernia, 923.
- COLEY, WILLIAM B.: Giant-cell Sarcoma of Tibia, 614; Osteosarcoma of Femur, 616; Treatment of Sarcoma of the Long Bones, 434.
- COLP, RALPH: Facial Nerve Division at Stylomastoid Foramen, 275; Fracture of the Surgical Neck of the Humerus, 274-277; Krukemberg Amputation, 277; Substernal Goitre, 280; Thrombosis of Ileo-cecal Veins Complicating Appendicitis, 926.

COMPÈRE, EDWARD L.: Bilateral Snapping Thumbs, 773.
 CONNORS, JOHN F.: Penetrating Stab Wounds and Bullet Wounds of the Chest, 528.
 CONWAY, FRANCIS M.: Traumatic Ulnar Neuritis, 425.
 COUNSELLER, VIRGIL S.: Strangulated Femoral Hernia, 717.
 COX, FOREST W.: Strangulated Femoral Hernia, 717.
 Cranial and Intracranial Injuries, Studies on, 327.
 Cutaneous, Extensive Burns, Study in, 670.
 CUTTING, REGINALD A.: Syphilitic Leg Ulcers, 85.
 Cyst of the Mesosigmoid, 465.
 Cysticercus of the Brain, 1.
 Cystocele, Strangulated Femoral, 724.
 Cysts, of External Semilunar Cartilage, 622; Mesenteric, 783.

D

DAVIS, JOHN STAIGE: Treatment of Old, Unhealed Burns, 648.
 Dead Bone Grafts to Repair Skull Defects, 321.
 Dermoid Cyst of Mediastinum, 135.
 DICKSON, THOMAS R.: Sarcoma of the Stomach, 68.
 Dislocation, Habitual, of the Shoulder, Nicola Operation for, 631; Lateral of Knee-Joint, 127.
 Dislocations, of the Patella Recurring External, 387-470.
 Diverticulosis, with Extrusion of Fecolithis into Omentum, 608; of Colon, 611.
 Diverticulum of Œsophagus, Recurrent, 299.
 DONOVAN, EDWARD J.: Bleeding Recurrent Duodenal Ulcer, 114; Sympathectomy for Hirschsprung's Disease, 771.
 DORRANCE, GEORGE M.: Musculospiral Paralysis, Tenoplasty for, 306; Plastic Operations on Neck, Lip and Axilla, 941; Resection of Mandible for Malignancy, 307; Tannic Acid Treatment of Burns, 786; Temporomandibular Ankylosis, 306.
 DOUGLAS, JOHN: Costal Chondritis, 921.

DOUGLASS, RICHMOND: Phrenic Neurectomy, 508.
 Duodenal Adhesions, Congenital, 790; Diverticulum, Perforation of, 787; Ulcer, Bleeding Recurrent, 114.

E

EBELING, WALTER W.: Primary Jejunal Ulcer, 857.
 Echinococcus Cyst, Influence of Removal on Blood Reaction, 119; with Calcified Adventitia, 118; of the Liver, 302.
 Ectopic Chorionepithelioma, 910.
 EGGERS, CARL: Dermoid Cyst of Mediastinum, 135-139; Diverticulosis of the Colon, 611; Hydronephrosis and Megaloureter, 139; Intestinal Granuloma, 132; Repair of Injured Bile-Ducts, 932.
 EISING, EUGENE H.: Irradiated Petrolatum, 929.
 Electrosurgery, 801.
 Elephantiasis Nostra, 226, 301.
 ELIASON, ELDRIDGE L.: Bilateral Ossified Hæmatoma of Elbow, 950; Echinococcus Cyst of the Liver, 302; Pylephlebitis following Appendicitis, 943; Splenic Abscess, 301.
 ELMER, WALTER G.: Intercostal Neuralgia of Abdominal Wall, 954.
 Epiphysis, Late Results of Separation of an, 189.
 ERDMAN, SEWARD: Hernia, involving Urinary Bladder, 937; Jejunostomy, 623; Repair of Injured Common Bile-Duct, 123, 930.
 ERDMANN, JOHN F.: Repair of Injured Bile-Ducts, 933.

F

Facial Nerve Division at Stylomastoid Foramen, 275.
 FARR, CHARLES E.: Mesenteric Cysts, 783; Torsion of the Omentum, 766-783.
 FELTER, ROBERT K.: Results of Treatment of Peptic Ulcer, 875.
 Femoral Cystocele, Strangulated, 724.
 Femoral Hernia, Strangulated, 717.
 Femur, Comminuted Fracture of, 611; Intracapsular Fractures of the Neck of the, 237, 310; Osteosarcoma of, 616.

INDEX

- FERGUSON, L. K.: Intramural Abscess of the Stomach, 304.
- FIELD, WILLIAM H.: Avertin Anæsthesia, 577.
- Fistula, Biliary, Transplantation of, into Stomach, 605; External Gastric, 950; of Nose, Congenital, 603.
- FONTAINE, RENÉ: Post-traumatic Painful Osteoporosis, 26.
- FORTUINE, STANLEY T.: Intersigmoid Hernia, 713.
- Fracture, of Cervical Vertebra, 281; of Femur, Comminuted, 611; of Forearm, Mal-union of, 635; of Neck of the Femur, Intracapsular, 237, 310; of Surgical Neck of the Humerus, 274.
- Fractures, at Ankle-Joint, Treatment of, 130; Carpal-Scaphoid, 209; of Head of Humerus, Non-reducible, Reconstructive Operation for, 217; of Head and Neck of the Radius, 204; Joint, Treatment of, 177; of Pelvis and Lower Limbs, the Overslung Traction Saddle Frame in the Treatment of, 309; Treatment of, in the Cincinnati General Hospital, 161.
- FRIEDMAN, LOUIS: Skin Conservation in Radical Mastectomy for Carcinoma, 844.
- Frontal Bone, Osteoma of, 314.
- G**
- Gall-Bladder, External Perforation of the, 464; Intrahepatic, Cholecystectomy for, 296.
- GARLOCK, JOHN H.: Fracture at Lower End of Tibia, 129; Free Full Thickness Skin Graft, 616; Lateral Dislocation of Knee-Joint, 127; Phlebitis Complicated by General Septic Invasion, 939; The Full Thickness Skin Graft, 259; Torsion of Omentum, 785.
- Gastric Fistula, External, 950.
- Gastric Symptoms Due to Thyroid Deficiency, 619.
- Gastric Ulcer, Jejunostomy for, 620.
- Gastro-Intestinal Tract, Inflammatory Tumors of, 889.
- Gastrojejunal Ulcer after Gastroenterostomy, 614.
- GIBBON, JOHN H.: Memoir of Emory Alexander, 159.
- GILL, A. BRUCE: Arthroplasty of Jaw for Ankylosis, 307.
- Goitre, Substernal, 280.
- GORDON, DONALD: Appendectomy, 287; Arthritis of Knee-Joint, 612; Comminuted Fracture of Femur, 611; Fracture of Neck of Femur, 613; Ileocecal Resection for Granuloma, 130.
- GRAHAM, HENRY F.: Appendicitis with Liver and Pleural Abscesses, 633; Hypertrophy of Sphincter Ani, 781; Nicola Operation for Habitual Dislocation of the Shoulder, 631; Repeated Gastroenterostomy on Same Patient for Intestinal Obstruction, 632; The Suture Material in Jejunostomy, 624.
- GRANT, FRANCIS C.: Buerger's Disease, 462; Chondroma of the Intervertebral Disks, 10.
- GRAY, HOWARD K.: Ultimate Prognosis after Resection of Carcinoma of Stomach, 882.
- GROVE, L. W.: X-ray Diagnosis of Common Duct Stones, 957
- GURDJIAN, ELISHA STEPHENS: Acute Cranial and Intracranial Injuries, 327.
- H**
- Hæmorrhage from Liver Controlled by Muscle Pack, 636.
- HALFORD, FRANCIS J.: Progressive Lenticular Degeneration, 796.
- Hand, Plastic Reconstruction of, 290.
- Heart Wounds, Cardiorrhaphy in, 547.
- Hemangioma of the Spine, Primary, 19.
- Hernia, Artificial Inguinal, 693; Intersigmoid, 713; into the Prevesical Space, 706; Involved in Bladder, 937; Retroperitoneal, 922; Strangulated Femoral, 717; Ventral Hernioplasty, 300.
- HERRMANN, LOUIS G.: Post-traumatic Painful Osteoporosis, 26.
- HINTON, J. WILLIAM: Gastric Resection Followed by Intestinal Obstruction, 617; Gastrojejunal Ulcer after Gastroenterostomy, 614; Repair of Injured Common Bile-Duct, 123; Thyroid Deficiency Followed by Gastric Symptoms, 619; Treatment of Post-pyloric Ulcer, 126.
- Hirschsprung's Disease, Sympathectomy for, 778-779.
- HITZROT, JAMES M.: Repair of Torn Crucial Ligaments, 128; Treatment of Fractures of Ankle-Joint, 130.

INDEX

Humerus, Fracture of the Surgical Neck of the, 274; Non-reducible Fractures of the Head of the, Reconstructive Operation for, 217.

Hydronephrosis with Megalo-ureter, 139.

HYMAN, ABRAHAM: Chronic Suppurative Perinephritis, Diagnosis of, 287.

Hypernephroma, Metastasis in, 153.

Hyperparathyroidism Simulated by Multiple Myeloma, 823.

I

Ileum, Granuloma of, Resection of Ileum, 130.

Inguinal Hernia, Artificial, 693.

Intersigmoid Hernia, 713.

Intervertebral Disks, Chondroma of the, 10.

Intestinal Conditions, Certain; Effects of Sympathetic Nerve Surgery in, 481.

Intestinal Obstruction, Post-operative, 617; Repeated Gastroenterostomy for, 632; Pouches after Colectomy, 116.

Intestine, Small, Tumors of the, 144.

Intracranial Injuries, Studies on, 327.

Intravenous Infusions, Continuous, in Acute Abdominal Crises, 749-787.

IRELAND, JAY: Late Results of Separation of an Epiphysis, 189.

Irradiated Petrolatum Treatment of Infected Tracts, 927.

Irradiation in Carcinoma of the Breast, 62.

IVY, ROBERT H.: Salivary Calculi, 155.

J

JACKSON, CHEVALIER: Bronchoscopic Observations in Post-operative Pulmonary Complications, 516.

JANSEN, CHARLES L.: Granuloma of Ileum, 132; Sympathectomy for Hirschsprung's Disease, 781.

Jaw, Arthroplasty of, for Ankylosis, 307.

Jejunal Ulcer, Primary, 857.

Jejunostomy, 623; for Gastric Ulcer, 620; Technic of, 553.

JOHNSTON, CHARLES G.: Continuous Intravenous Infusions in Acute Abdominal Crises, 749.

Joint Fractures, Treatment of, 177.

JONES, LAURENCE: Intracapsular Fractures of the Neck of the Femur, 237; Reconstructive Operation for Non-

reducible Fractures of the Head of the, 217.

JORDAN, CLAUS G.: Elephantiasis Nostra, 226, 301.

K

KAPLAN, IRA I.: Irradiation in Carcinoma of the Breast, 62.

KEEN, WILLIAM WILLIAMS, Memoir of, 476.

KENNEDY, ROBERT H.: Congenital Fistula of the Nose, 603; Fibroma of the Stomach, 602; Mal-united Fractures, 635.

KEYES, E. LAURENCE: Observations of Rupture of Supraspinatus Tendon, 849.

KITLOWSKI, EDWARD A.: Treatment of Old, Unhealed Burns, 648.

KLINGENSTEIN, PERCY: Appendicitis with Thrombosis of Mesenteric Veins, 925; Repair of Injured Common Bile-Duct, 123; Torsion of Omentum, 785.

Klippel-Feil, Syndrome, 473.

Knee-Joint, Acute Suppurative Arthritis of, 612; Lateral Dislocation of, 127.

KNOX, HARRY E.: Congenital Duodenal Adhesions, 790.

Krukenberg Amputation, 277.

KULOWSKI, JACOB: Arm-Chest Adhesions and Their Plastic Reconstruction, 683.

L

LAROQUE, G. PAUL: Partial Hysterectomy and the Use of the Stump of the Uterus to Support the Bladder in the Vaginal Operation for Prolapse, 74.

Laryngeal Nerve, Inferior, Anomaly of the, 828.

LAZARUS, JOSEPH A.: Tropacocaine in Spinal Anæsthesia, 757.

LEE, WALTER E.: Adrenal Tumors and Precocious Sexual Development, 153; Tannic Acid Treatment of Burns, 786; Urogenital Cyst of the Mesosigmoid, 465.

Leg Ulcers, Syphilitic, 85.

LEITHAUSER, DANIEL J.: Care of Ollier-Thiersch Skin Grafts, 311.

Lenticular Degeneration, Progressive, 796.

LESTER, CHARLES W.: Treatment of Post-pyloric Ulcer, 124.

LEVERING, J. WALTER: Perforation of Duodenal Diverticulum, 787.

INDEX

LEWISOHN, RICHARD: Cure Following Removal of Echinococcus Cyst, 121; Treatment of Post-pyloric Ulcer, 124.
 LILIENTHAL, HOWARD: Electrosurgery, 801; Jejunostomy, 624.
 Lip, Plastic Operations on, 941.
 LIPSCHUTZ, BENJAMIN: Intercostal Neuralgia of Abdominal Wall, 953; Myositis Ossificans, 950.
 Liver, Echinococcus Cyst of the, 302; Hæmorrhage from, Muscle Pack to Control, 636; Tumor of, Adrenal Origin, 150.
 Loop in Bandaging, 798.
 LOVELL, HAROLD W.: Cysticercus of the Brain, 1.

M

MACFEE, WILLIAM F.: Free Full Thickness Skin Grafts, 616.
 MCBRIDE, EARL D.: Overslung Fraction Saddle Frame in the Treatment of Fractures of Pelvis and Lower Limbs, 309.
 MCCREERY, JOHN: Tumors of the Small Intestine, 145.
 MCIVER, MONROE A.: Study in Extensive Cutaneous Burns, 670.
 McLAUGHLIN, CHAS.: Pylephlebitis Following Appendicitis, 943.
 McQUILLAN, ARTHUR S.: Paræsoophageal Abscess, 298.
 MAGE, SIGMUND: Treatment of Joint Fractures, 177.
 MAMIKONOFF, MICHAEL: Cardiorrhaphy in Wounds of the Heart, 547.
 Mandible, Resection of, 306, 307.
 MASON, JAMES B.: Tannic Acid Treatment of Burns, 641-786; Tumor of Liver of Adrenal Origin, 150.
 Mastectomy, Radical, for Carcinoma, Skin Conservation after, 844.
 MATHEWS, FRANK S.: Treatment of Post-pyloric Ulcer, 125; Visceral Torsion, 784.
 MEADE, RICHARD H.: Localized Tuberculosis of the Chest Wall, 247, 301.
 Mediastinum, Dermoid Cyst of the, 135.
 MELENEY, FRANK L.: Tetanus, Post-operative, 937.
 MEMOIRS: Emory Alexander, 159; Willy Meyer, 156; George Howard Monks, 957.

MENVILLE, JOHN G.: Subcutaneous Angiomas of the Breast, 401.
 Mesenteric Cyst Obstructing Bowel, 639.
 Mesenteric Cysts, 783.
 Mesenteric Veins, Thrombosis of, Complicating Appendicitis, 925.
 Mesosigmoid, Urogenital Cyst of the, 465.
 Metastases in Hypernephrosis, 153.
 MEYER, WILLY: Memoir of, 156.
 MILCH, HENRY: Interscapulo-Thoracic Amputation, 381.
 MOGAVERO, FRANK: Continuous Intravenous Infusions in Acute Abdominal Infections, 787.
 MONKS, GEORGE HOWARD: Memoir of, 957.
 MORRIS, JOHN H.: Inflammatory Tumors of Gastro-intestinal Tract, 889; Irradiated Petrolatum in Treatment of Intestinal Fistula, 921; Retroperitoneal Hernia with Volvulus, 922; Subtotal Resection of Stomach for Carcinoma, 924; Suppurative Chondritis of Costal Cartilages, 920; Torsion of Omentum, 785.
 MOSCHOWITZ, ALEX.: Suppurative Costal Chondritis, 921.
 MULLER, GEORGE P.: Effect of Blood in Experimental Peritonitis, 470; Elephantiasis Nostra, 226-301; External Perforation of the Gall-Bladder, 464; Splenectomy for Sick-cell Anæmia, 150; Sympathectomy for Buerger's Disease, 462.
 MURRAY, CLAY RAY: Fractures of the Surgical Neck of the Humerus, 274.
 Muscle Pack to Control Hæmorrhage from Liver, 636.
 Musculo-spiral Paralysis, 306.
 Myeloma, Multiple, Simulating Hyperparathyroidism, 823.
 Myositis Ossificans, 950.

N

NARAT, JOSEPH K.: Removal of Brilliant Green Stains, 800.
 Neck, Plastic Operations on, 941.
 Nerve, Inferior Laryngeal, Anomaly of the, 828.
 Nervous System, Autonomic, Surgical Aspects of the, 494.
 NEUHOF, HAROLD: Acute Phlebitis Complicated by General Septic Invasion, 939; Diagnosis and Operative Control of

Acute Pyogenic Phlebitis with General Septic Invasion, 808; Mesenteric Phlebitis, 926.
 Neurectomy, Phrenic, 508.
 Neuritis, Traumatic Ulnar, 425.
 NEW YORK SURGICAL SOCIETY: Transactions of March 9, 1932, 114; April 13, 1932, 127; April 27, 1932, 274; May 11, 1932, 602; October 12, 1932, 617; October 31, 1932, 626; November 9, 1932, 778; November 23, 1932, 920.
 NICKEL, ALLEN C.: Multiple Myeloma Simulating Hyperparathyroidism, 823.
 Nose, Congenital Fistula of, 603.

O

OCHSNER, EDWARD H.: Wolff's Law as to the Internal Structure of Bone, 318.
 Œsophageal Abscess, 298.
 Œsophagus, Recurrent Diverticulum of the, 299.
 Omentum, Torsion of the, 766-783.
 Osteoma of Frontal Bone, 314.
 Osteomyelitis, Chronic, Resulting in Carcinoma of Both Legs, 947; of Skull, 626, 733.
 Osteoporosis, Painful, Post-traumatic, 26.
 OTT, WILLIAM O.: Osteoma of the Frontal Bone, 314.
 OWEN, HUBLEY R.: Mistaken Diagnoses of Abdominal Pain, 953; Ventral Hernia-Hernioplasty, 300.

P

Paget's Disease of Bone Mistaken for Carcinoma, 621.
 PANKRATIEV, BORIS E.: Dead Bone Grafts to Repair Skull Defects, 321.
 PARSONS, WILLIAM BARCLAY, JR.: Hypertrophy of Pylorus with Ulcer of Stomach, 141; Thyro-Glossal Fistula, 143.
 Patella, Recurring External Dislocations of the, 387-470.
 PATTERSON, RUSSELL, H.: The Nicola Operation for Habitual Dislocation of Shoulder, 631.
 Pellagra Following Blind Intestinal Pouches, 117.

Pelvis and Lower Limbs Fractures, Fraction Saddle Frame in the Treatment of, 309.
 PENNOYER, GRANT P.: Excision and Skin Graft of Varicose Ulcer, 630; Osteomyelitis of the Skull, 626; Post-operative Tetanus, 935; Sarcoma of Lower Extremities, 627.
 Peptic Ulcer, Results of Treatment of, 875.
 Perinephritis, Chronic Suppurative, Diagnosis of, 286.
 Periosteum, Chemical Treatment of the, to Inhibit Rib Regeneration in Thoracoplasty, 368.
 Peritonitis, Experimental, Effect of Blood in, 414-474; Rheumatic, 792.
 PETERSON, EDWARD W.: Carcinoma of Transverse Mesocolon Cyst, 782; Hirschsprung's Disease, Sympathectomy for, 779; Intestinal Granuloma, 134.
 Petrolatum, Irradiated, in Treatment of an Intestinal Fistula, 921; in Pleural Fistula, 927.
 PHILADELPHIA ACADEMY OF SURGERY: Transaction of March 7, 1932, 146; Meeting April 4, 1932, 300; Transactions of May 2, 1932, 461; Stated Meeting October 3, 1932, 786; November 7, 941.
 Phlebitis, Acute Pyogenic with General Septic Invasion Diagnosis and Operative Control of, 808, 939, 940.
 Phrenic Neurectomy, 508.
 PICK, CHARLES J.: Tropacocaine in Spinal Anæsthesia, 757.
 PICKHARDT, OTTO C.: Colectomy, Partial; Blind Pouch Development after, 116, 117; Echinococcus Cyst, 118; Echinococcus Cyst, Influence of Removal on Blood Reaction, 119.
 PILCHER, LEWIS S., 2d: Avertin Anæsthesia, 577.
 Pilonidal Sinus, 80.
 Pituitary Body, X-ray Therapy of, after Splenectomy for Purpura, 290.
 Plastic Operations on Neck, Lip and Axilla, 941.
 Plastic Reconstruction of Hand, 290.
 Pott's Fractures Unreduced. Treatment of Mal-union Following, 394.
 Prevesical Space, Hernia into the, 706.
 Pulmonary Complications, Post-operative, Bronchoscopic Observations on, 516.

INDEX

Purpura, Chronic Thrombocytopenic, Splenectomy for, 288, 289.

R

RADEMAKER, LEE: Effect of Blood in Experimental Peritonitis, 414-470.

Radius, Fractures of the Head and Neck of the, 204.

RAEFORD, THEODORE S.: Carcinoma of Rectum in Thirteen-Year-Old Girl, 903.

RANDALL, ALEXANDER: Bladder Injuries, 154.

RANSOHOFF, J. LOUIS: Sarcoma of the Stomach, 68.

RAVDIN, ISIDOR G.: Continuous Intravenous Infusions in Acute Abdominal Crises, 749-787.

READ, JOSEPH C.: X-ray Common Duct Stones, 957.

Rectum, Carcinoma of, in Thirteen-Year-Old Girl, 903.

REICHERT, FREDERICK LEET: Intermittent Claudication Gangrene Controlled by Sympathetic Nerve Block, 503.

Retroperitoneal Sarcoma, 146.

Rib Regeneration, Inhibition of in Thoracoplasty by Chemical Treatment of Periosteum, 368.

ROSENTHAL, ARTHUR A.: Tropicocaine in Spinal Anæsthesia, 757.

ROSH, RIEVA: Irradiation in Carcinoma of the Breast, 62.

ROTHSCHILD, NORMAN S.: External Gastric Fistula, 950.

RUSSELL, THOMAS H.: Repair of Injured Common Bile Duct, 121-123.

S

Saddle Frame, Overslung Fraction, for Fractures, 309.

Sarcoma, Giant-cell, of Femur, 616; Giant-cell, of Tibia, 614; of Long Bones, Treatment of, 434; Retroperitoneal, 146; of Stomach, 68; of Thigh, 627.

SEARS, JOHN H.: Ectopic Chorion-epithelioma, 910.

SEMKEN, GEORGE H.: Sarcoma of Lower Extremity, 628.

Shoulder, Habitual Dislocation of, Nicola Operation for, 631; Infected Tubercu-

losis of, Interscapulo-Thoracic Amputation for, 381.

Skin, Avulsion of, about Elbow, 634.

Skin Conservation in Radical Mastectomy for Carcinoma, 844.

Skin Graft, the Full Thickness, 259, 616; of Large Varicose Ulcer, 630; Ollier-Thiersch, the Care of, 311.

Skull Defects Repaired by Dead Bone Grafts, 321.

Skull, Osteomyelitis of, 626, 733.

SMITH, MORRIS K.: Cysts of External Semilunar Cartilage, 622; Paget's Disease of Bone Mistaken for Carcinoma, 621.

SMYTH, CALVIN M., JR.: Rheumatic Peritonitis, 793.

SNODGRASS, LEEMAN E.: End-Results of Carpal-Scaphoid Fractures, 209.

SPEESE, JOHN: Tumor of Liver of Adrenal Origin, 150.

Spinal Anæsthesia, Tropicocaine in, 757.

Spine, Extension of, in Cases of Fracture of Vertebrae, 285; Intervertebral Disks of, Chondroma of, 10; Primary Hæmangioma of the, 19.

Splenectomy, for Purpura, 288; for Sickle-cell Anæmia, 146.

Splenic Abscess, 301.

Stains, Brilliant Green, Removal of, 800.

STENBUCK, JOSEPH B.: Penetrating Stab Wounds and Bullet Wounds of the Chest, 528.

STETTEN, DEWITT: Fracture of Sixth of Sixth Cervical Vertebra, Laminectomy for, 281, 285; Repair of Injured Bile-Ducts, 933; Resection of Blind Pouch Developing after Colectomy, 117.

STEWART, STEELE F.: The Surgery of the Sympathetic Nervous System, 485.

Stomach, for Cancer, Resection of, Factors Influencing Ultimate Prognosis, 882; for Carcinoma, Subtotal Resection of, 924; Fibroma of, 602; Intramural Abscess of the, 304; Ulcer of, with Hypertrophy of Pylorus, 141.

STOOKEY, BYRON: Facial Nerve Repair, 277; Fracture-Dislocation of Cervical Vertebra, 284.

Supraspinatus Tendon, Observations on Rupture of, 849.

Sympathectomy for Hirschsprung's Disease, 778.

INDEX

Sympathetic, Surgery of the, 481, 485, 494, 503.

Sympathetic Nerve Block to Control Intermittent Claudication without Gangrene, 503.

Sympathetic Nerve Surgery in Certain Intestinal Conditions, 481.

Sympathetic Nervous System, Surgery of the, 485.

Syphilitic Leg Ulcers, 85.

T

Tannic Acid Treatment of Burns, 641-786.

Temporo-mandibular Ankylosis, 306, 307.

Testis, Embryonal Carcinoma of, 615.

Tetanus following Appendectomy, 934; Post-operative, 935.

Thigh, Sarcoma of, 627.

Thoracoplasty, Chemical Treatment of Periosteum in, to Inhibit Rib Regeneration, 368.

Thumbs, Snapping, Bilateral, 773.

Thyro-Glossal Fistula, 143.

Thyroid Deficiency Followed by Gastric Symptoms, 619.

Thyroidectomy, Amount of Gland to Be Left after, 831.

TOREK, FRANZ: Memoir of Willy Meyer, 156; Recurrent Diverticula of Œsophagus, 299.

Torsion, of the Omentum, 766-783; Visceral, 784.

Tropacocaine Hydrochloride in Spinal Anæsthesia, 757.

Tuberculosis, of Chest Wall, Localized, 247, 301; of Shoulder, Interscapulo-Thoracic Amputation for, 381.

Tumor of Liver, Adrenal Origin, 150.

Tumors, of Gastro-Intestinal Tract, Inflammatory, 889; of Small Intestine, 144.

U

Ulcer, Duodenal Bleeding Recurrent, 114; Peptic, 875; Primary Jejunal, 857.

Ulcers of Leg, Syphilitic, 85.

Ulcers, Postpyloric, Management of, 123.

Ulnar Neuritis, Traumatic, 425.

Ureter, Megalo, with Hydronephrosis, 139.

Urogenital Cyst of the Mesosigmoid, 465.

V

Vaginal Prolapse, Operation for, with Use of Stump of Uterus to Support Bladder after Partial Hysterectomy, 74.

VAN ALLEN, C. M.: Chemical Treatment of Periosteum in Thoracoplasty to Inhibit Rib Regeneration, 368.

VAN NUYS, R. G.: Primary Hæmangioma of the Spine, 19.

Varicose Ulcer, Large, Excision and Skin Graft of, 630.

VASTOLA, ANTHONY P.: Strangulated Femoral Cystocele, 724.

VICKERS, DENVER M.: Intersigmoid Hernia, 713.

W

WAGNER, LOUIS CLARK: Treatment of Mal-union following Unreduced Pott's Fracture, 394.

WALKER, IRVING J.: Hernia into the Pre-vesical Space, 706.

WEBER, EDWARD H.: Rheumatic Peritonitis, 792.

WEEDER, S. DANA: Abdominal Pain Due to Extra-Abdominal Causes, 952.

WEINSTEIN-MANDEL: Pilonidal Sinus, 80.

WEINTRAUB, SYDNEY: Results of Treatment of Peptic Ulcer, 875.

WETHERELL, FREDERICK S.: Sympathetic Nerve Surgery in Certain Intestinal Conditions, 481.

WHIPPLE, ALLEN O.: Dermoid Cyst of Mediastinum, 138; Jejunostomy, 623; Pellagra Following Intestinal Ulceration of Blind Pouches, 117; Splenectomy for Purpura, 289.

WHITE, RICHARD JOSEPH: Spontaneous Correction of Birth Fracture Deformity, 639.

WHITMAN, ROYAL: Treatment of Intra-capsular Fractures of the Neck of the Femur, 310.

WILLARD, DEFORREST P.: Klippel-Feil Syndrome, 473; Multiple Traumatic Bursitis, 471.

WILLIAMS, GEORGE DEE: Anomaly of the Inferior Laryngeal Nerve, 828.

INDEX

- Wilson's Disease, 796.
WINDSBERG, ESKE HARRY: Artificial In-
guinal Hernia, 693.
Wolff's Law as to the Internal Structure
of Bone, 318.
WOLFSON, WILLIAM L.: Inter-ringed
Clamp, 794.
Wounds of the Heart, Cardiorrhaphy in,
547.
Wounds, Penetrating, of the Chest, 528.
- Y**
- YASKIN, J. C.: Chondroma of the Inter-
vertebral Disks, 10.

